THE WEEK'S EVENTS

Concrete Pipe Found To Be Monopolized

FTC orders Eastern Seaboard manufacturers to stop unfair trade practice

Four manufacturers of concrete pipe and other concrete products who were found to do about 40 per cent of the concrete pipe business in the Eastern Seaboard territory from New Jersey south to North Carolina and about 75 per cent of such business in Virginia, Maryland and the District of Columbia, have been ordered by the Federal Trade Commission to cease and desist from practices involving a conspiracy to suppress competition in their territory.

Companies named

In 1934, the commission found, four companies jointly organized the Arlington Concrete Pipe Corp. of South Washington, Va. The companies named by the commission are: The Lock Joint Pipe Co. of East Orange, N. J.; Gray Concrete Pipe Co. of Thomasville, N. C.; Mid-Atlantic Concrete Pipe & Products Co. of Norfolk, Va., and the Concrete Pipe & Products Co. of Richmond.

The commission found that the companies named had refused to submit independent competitive bids to prospective customers, had sold and bid jointly on concrete pipe in the name of the Arlington corporation, and had sold pipe through the Arlington corporation below production cost. The commission ordered the companies to desist from all of these practices.

FIRST SECTION OF CENTRAL VALLEY PROJECT COMPLETED

As THE DRAGLINE, above, completed work on the first 4-mile section of the Contra Costa Canal, initial item in the Central Valley project in California, a work order was given to Pearson, Minnis & Moody and Werner & Webb to start work on the second 8-mile section of the canal.

Work on the first section, 4 miles long, was started last October by Haas, Doughty & Jones and Marshall & Stacy, the contractors. In addition to the earth ditch, the completed work includes four reinforced concrete siphons and six farm bridges thrown over the canal.

The new 8-mile section will be a concrete-lined ditch about 25 ft wide at the water surface. It includes a short tunnel, seven siphons, and five highway bridges.

The Contra Costa Canal will eventually run 46 miles from the San Joaquin River to a point near Martinez, affording a supplementary supply of fresh water to industrial plants along the south shore of Suisun Bay and to several Contra Costa County municipalities and farmlands.

MAJOR NEWS

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Dynamite Blast Kills Two On Montreal Sewer Job

Two workmen were killed and three others injured in a dynamite explosion on a sewer construction project in Montreal Aug. 2.

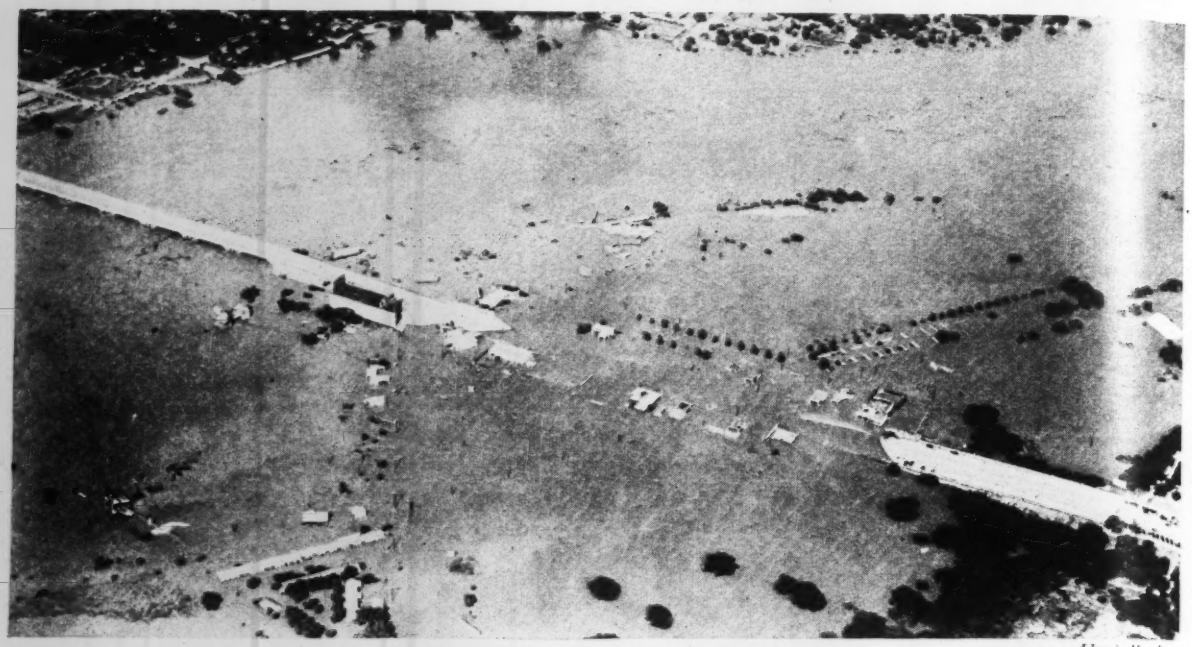
The accident is believed to have been caused by a compressed air drill, operated by one of the men who was killed, striking an unexploded stick of dynamite. A charge had been fired two hours before the accident, and at the time of the accident workmen were engaged in drilling for a new charge.

The sewer is being constructed in open cut along Barclay St. by Frank Lapalme, Ltd., under a construction contract with the city.

Wage-Hour Amendment On N. Y. Public Works

Provision for a 40-hr. week and payment of prevailing wages on public works in New York State would be incorporated in the state constitution under the terms of an amendment which has been passed by the New York State constitutional convention and will be submitted to the electorate in the fall.

The proposed amendment provides that "No laborer, workman or mechanic in the employ of a contractor or subcontractor engaged in the performance of any public works will be permitted to work more than 8 hours in any day or more than five days in any week, except in cases of extraordinary emergency; nor shall he be paid less than the rate of wages prevailing in the same trade or occupation in the locality within the state where such public works is to be situated."



Lloyd M. Long

COLORADO RIVER OF TEXAS IN FLOOD

DURING THE FLOOD of late July, the Colorado River overflowed into its flood channel at Austin, Texas, and drowned out the Congress Ave. viaduct. Failure of Buchanan Dam to check the flood has resulted in investigations now under way by the state legislature and by federal engineers named by Secretary of the Interior Ickes (*ENR*, Aug. 4, 1938, p. 126). Buchanan Dam is the first of four being built by the Lower Colorado River Authority.

Boston PWA Grant Dropped Because of City Delays

Initiating a policy of rescinding allotments not taken up promptly by municipalities, the Public Works Administration has withdrawn a grant of $1,125,000 to the city of Boston, intended to aid in construction of a new city hall. The PWA made its offer of a grant on June 28, but the city had taken no action toward accepting the allotment. The original application by the city was made in 1935 and it had been renewed since.

It was announced that the same policy would be followed in the case of other cities which failed to accept allotments within a reasonable time. The funds, it was stated, will be re-allotted to other projects which can meet the deadline.

New York refuses loan

Meanwhile, PWA found another city not anxious for its services when Mayor LaGuardia of New York City asked that agency to cancel its offer of a $2,715,000 loan which was to have been used in building a new administration building for Hunter College. The city, LaGuardia said, can borrow the money privately at a lower interest rate than the 4 per cent which PWA charges. The city has recently been paying about 3 per cent on its new bond issues.

CALENDAR OF MEETINGS

NATIONAL SOCIETIES

INTERNATIONAL CONGRESS FOR INDUSTRIAL ACCIDENTS AND OCCUPATIONAL DISEASES, Frankfort-on-the-Main, Germany, Sept. 26-30.

AMERICAN PUBLIC WORKS ASSOCIATION, annual meeting, New York City, Oct. 3-5.

NATIONAL SAFETY COUNCIL, annual congress, Stevens Hotel, Chicago, Oct. 10-14.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, annual convention, French Lick Springs, Ind., Oct. 10-14.

NATIONAL RECLAMATION ASSOCIATION, annual meeting, Reno, Nev., Oct. 11-13.

AMERICAN SOCIETY OF CIVIL ENGINEERS, fall meeting, Rochester, N. Y., Oct. 12-14.

LOCAL AND REGIONAL

WESTERN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual convention, Reno, Nev., Aug. 10–13.

AMERICAN WATER WORKS ASSOCIATION, local section meetings scheduled: Central States, Wheeling, Aug. 17-19. New York, Poughkeepsie, Sept. 22-23. Wisconsin, in Milwaukee, Oct. 10-12.

NEW ENGLAND WATER WORKS ASSOCIATION, annual convention, Hotel Statler, Boston, Sept. 13-16.

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Boston Subway Extension Approved by Washington

A $5,000,000 extension of the subway now under construction under Huntington Avenue, Boston, has been approved by the Washington authorities, and only formalities remain before work can be started. The new line will extend from the Mechanics Building to the Boston Opera House, with an underpass at Huntington and Massachusetts Avenues and stations at the Mechanics Building and Symphony Hall. It will connect with the present extension being built from Copley Square to the Mechanics Building, and will result in the removal of all trolley cars from Boylston Street and Huntington Avenue as far west as the Opera House district.

The federal government will contribute about $3,900,000 toward the project, which will be a WPA job. It is expected that the work will give employment to 4,000 men for two years. About 25,000 automobiles per day pass through the present Massachusetts Avenue-Huntington Avenue intersection between 8 a.m. and 6 p.m

Review Commission Named On Chicago Subway

Public Works Administrator Ickes has appointed a commission of four engineers to study the plan for the proposed Chicago subway on which an application for PWA funds is now pending.

The commission is ordered to report on the engineering features of the project, "with particular reference to the efficiency of the plan for its construction, the time within which work which is thereafter to be continuously prosecuted may be started, and the date when it is reasonable to expect that the project can be completed," Ickes announced.

"More than this," the administrator said, "I would like your commission to consider the plan with particular attention to the social desirability of the proposed project. Would this subway, if built, be such an enterprise as engineers and city planners looking as far into the future as one can reasonably be expected to look, propose for construction? . . ."

A grant of $14,328,000 has been asked for the $26,000,000 subway project. The project will involve construction of a 2.6-mi. north and south subway in State St., a 1.3-mi. east and west subway in Washington St., and a 1.1-mi. east and west subway in Jackson Boulevard.

The engineers named to the review commission are Henry M. Waite, former first assistant PWA administrator and once city engineer of Chicago, chairman; Joshua D'Esposito, resident engineer for the Chicago Sanitary District and former state PWA director for Illinois; Robert Ridgeway, former chief engineer, New York City board of transportation; and Henry M. Brinckerhoff, New York City consulting engineer who was formerly the chief engineer of the Chicago subway commission.

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Pennsylvania Acts Against Philadelphia Sewage

Asserting that the city of Philadelphia "is now discharging sewage into the Delaware River and the lower Schuylkill River without a permit from the sanitary water board," the Pennsylvania attorney-general's office has served notice on the city council of Philadelphia that its delay in providing sewage treatment equipment "can no longer be tolerated."

The letter to the council pointed out that "the city has also breached the contract and agreement which it made with the state in 1922 to appropriate $3,000,000 annually toward the construction of a sewage system. The commonwealth is willing to withhold action only so long as we are assured that the council will make prompt provision for meeting its obligations in this regard. . . .

"Under both the sewage rental act and the pure stream act," the letter pointed out, "ample means are provided for establishing sewage disposal in conjunction with the waterworks as a self-liquidating project, either by means of non-debt revenue bonds secured by the income derived from sewer rental or by other bonds which would not be charged against the borrowing capacity."

In thus initiating action against the state, the attorney-general's office was carrying out a request made last month by the state sanitary water board (*ENR*, July 14, 1938, p. 39). An act passed last year by the Pennsylvania legislature empowers the state water board to forbid municipalities to pollute streams in the commonwealth. (*ENR*, July 8, 1937, p. 47) and authorizes use of sewer rental bonds.

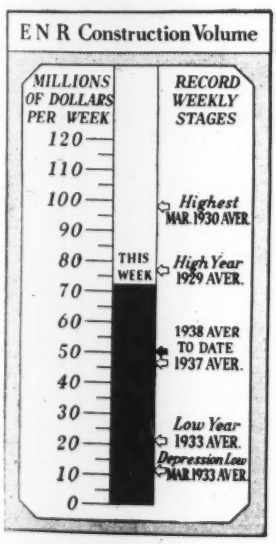
CONTRACTS AND CAPITAL

ENGINEERING construction awards for the week, $76,431,000, are 33 per cent above last week and 69 per cent above the corresponding 1937 week. This week's total brings the heavy construction volume for 1938 to date to $1,612,149,000, an increase of 1.1 per cent over the $1,594,818,000 reported for the 32-week period last year.

Private construction is 77 per cent above a week ago and 43 per cent above the 1937 week due to the high volume of commercial building and large-scale housing projects. Public construction tops the preceding week by 22 per cent and the week a year ago by 80 per cent. The large waterworks and highway totals are responsible for the gains.

The $21,333,000 award for New York City Delaware Aqueduct water supply tunnels in Westchester County boosted waterworks to its second highest weekly total of the year. Streets and roads and commercial buildings also report gains over last week. Waterworks, bridges, commercial buildings and large-scale housing, earthwork and drainage, streets and roads, and unclassified report increases over their 1937-week totals.

New capital for construction purposes for the week totals $121,634,000, a gain of 388 per cent over the corresponding 1937 week's volume Construction financing for 1938 to date, $2,637,217,000, is 176 per cent higher than in the 32-week period last year.



CONTRACTS

(Thousands of dollars)

	Week Ending Aug. 12 1937	Aug. 4 1938	Aug. 11 1938
Federal	$7,288	$14,864	$9,739
State & Municipal	23,888	31,113	46,354
Total public	$31,176	$45,977	$56,093
Total private	14,172	11,477	20,338
TOTALS	$45,348	$57,454	$76,431

Cumulative

1938 .... (32 weeks)		$1,612,149
1937 .... (32 weeks)		$1,504,818

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1937 32 Wk.	1938 32 Wk.
NON-FEDERAL	$956,266	$1,493,275
State & Mun. bonds	354,586	361,710*
Corporate securities	359,706	242,243
PWA loans, grants	12,035	424,774*
RFC loans	29,939	96,891*
U.S.H.A. loans	....	154,528
R.E.A. loans	....	11,629
Federal Aid - Highways	200,000	201,500
FEDERAL	$57	$1,143,942*
TOTAL CAPITAL	$956,323	$2,637,217

* $58,000,000 for Pennsylvania Turnpike Commission transferred from Federal and State and Municipal to PWA and RFC financing.

FHA MORTGAGES

	Cumulative 1937 31 Wk.	1938 31 Wk.
Mortg. selected for appraisal	$393,409	$565,213

ENR INDEX NUMBERS

Index Base		1913	1926
Construction Cost	Aug.	232.39	111.71
Building Cost	Aug.	194.49	105.14
Volume	July	207	91

J. G. Sullivan Dies; Railroad Engineer

Howard McClintic of bridge firm dies at 72—Tibbetts a suicide in California

John G. Sullivan, former chief engineer of the Canadian Pacific Railway and assistant to John F. Stevens on the Panama Canal, died in Winnipeg on Aug. 7, aged 75 years. Sullivan is probably the last of a large number of American engineers who after gaining some practical experience on our western roads went to Canada in the early days of railroad expansion there. Many remained in Canada and were largely responsible for the similarity of railroad construction practices that exists in the two countries.

Sullivan was born at Bushnell's Basin, N. Y., and graduated from Cornell as a civil engineer in 1888. Some of his early experience was gained under John F. Stevens in charge of heavy work on the Martin Creek Loop on the Northern Pacific in 1892. When Stevens was chief engineer of the Panama Canal work he had Sullivan as one of his principal assistants from Sept. 1905 to Jan. 1907.

Except for that period Sullivan's service with Canadian Pacific was continuous from 1900 to 1928, mostly on western lines where he was responsible for much of the heavy reconstruction work in the mountains. He served as chief engineer for the entire system from 1915 to 1918. Subsequently he served as consulting engineer for ten years and since 1928 has been in private practice. He is a past president of the Engineering Institute of Canada and the American Railway Engineering Association.

HOWARD H. MCCLINTIC, one of the founders of the McClintic-Marshall Construction Co., steel fabricators, died in Pittsburgh Aug. 5 at the age of 72. McClintic graduated in civil engineering from Lehigh University in 1888 and at the turn of the century he organized McClintic-Marshall in association with Charles D. Marshall. The company became one of the largest steel fabricating concerns in the country, being valued at about $64,000,000 in 1931 when it was merged with Bethlehem Steel.

FRED H. TIBBETTS, 56, San Francisco consulting engineer, committed suicide Aug. 2 near Hollister, Calif., where he had attended a meeting of the directors of the Pacheco Pass project, for which he was chief engineer. He is believed to have been despondent over failing eyesight. Tibbetts had worked throughout the West on irrigation and water conservation as chief engineer or consultant and recently completed a group of five dams for the Santa Clara Valley Water Conservation District.

J. B. YOUNG, engineer of tests for The Reading Co., died July 30. Young had been with the Reading Co. since 1907 and had been engineer of tests since 1918. He was an active member of the American Society for Testing Materials, participating in the work of several committees.

JOHN J. VAN VALKENBURGH, consulting civil engineer, died in Framingham, Mass., Aug. 3 at the age of 83. A graduate of Worcester Polytechnic Institute, Van Valkenburgh worked with Simpson C. Heald from 1883 to 1889. In the latter year he became town engineer of Framingham, a position which he held for many years.

WILLIAM N. ALLISON, 29, an engineer since 1934 with the Bureau of Reclamation at Grand Coulee Dam, died July 29 at Amarillo, Texas. Allison graduated from the University of Washington in 1931.

JOHN H. GRAY, steel contractor and consulting engineer who retired in 1917, died in Orange, N. J., Aug. 5 at the age of 74. Gray, the inventor of the Gray column, was steel contractor on many New York theatres, on the Reliance and Fisher buildings in Chicago and on the Hudson River bridge at Troy. Gray was graduated from Rensselaer Polytechnic Institute in 1887.

JOHN W. BROWN, railroad construction engineer, died in Englewood, Calif., Aug. 3 at the age of 69. He worked for many years in Mexico for the Southern Pacific Line and was the builder of the famous railroad in Death Valley.

NELSON E. GUTELIUS, engineer of maintenance of way on the eastern lines of the Canadian Pacific Railway, died July 30 at the age of 55.

CONWAY E. CARTWRIGHT, 74, retired division engineer for the Canadian Pacific at Vancouver, died there recently.

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Contractor Must Pay State Sales Tax

The contractor, rather than the city, must pay a state sales tax on material purchased for municipal construction projects, the corporation counsel of Seattle has ruled. The Schulman Electric Co. of Chicago, installing electrical facilities for the city light department, had asserted that it had not included the sales tax in estimates when bidding for the work.

TVA Finances Probed At Private Expense

Investigating committee authorizes use of private funds to pay accountants

The first privately financed investigation into the books, costs, allocations, and expenditures of the Tennessee Valley Authority is now under way due to the embarrassment the special Congressional committee investigating TVA has encountered in obtaining any information except through witnesses on the TVA payroll. Special accountants have been employed by Senator Davis, of Pennsylvania with funds furnished, he says, by two unidentified private persons. Their right to examine all TVA records, books and files has been approved by Chairman Donahey, of the committee.

The independent experts are to gather, Senator Davis said, data on how much money government agencies other than TVA have spent in furthering TVA objectives. The idea here is to develop Arthur E. Morgan's charge that the cost of developing power sales was much greater than TVA admitted, because the expenditures of other agencies were not included, though all of the money came from the federal treasury.

Questions by Representative Charles A. Wolverton showed that at least $2,500,000 of federal money was spent by the CCC and other federal agencies in cooperation with TVA's reforestation and soil conservation work. TVA's figure on this had been $2,000,000, so that the total was $4,500,000.

Thereupon the committee directed TVA officials to produce expenditures by other government agencies in connection with TVA projects.

Some sharp criticism on the part of Representative Wolverton followed disclosure that TVA had given $1,700,000 to land grant colleges so far for experimental work for the benefit of agriculture. There was much discussion of the expenditures aiming at a new process for quick freezing of strawberries, so they could be shipped in the new refrigerator barge TVA has built for hauling the frozen fruit over the Tennessee river when its navigation development makes that possible.

Most of the committee's time last week was spent in going into the purchase of phosphate land from the International Agricultural Corporation, at a profit to the company of $530,000.

Harry A. Curtis, TVA's chief chemist, took full responsibility for this. His argument was that it was the best deal that could be made. It represented about 11c. a ton on the estimated vol-

ume of rock in the deposit, as against one other purchase which ran as low as 3c, and one which ran 7c. But this big tract was all together, Curtis pointed out, and the economy in operation therefore more than offset the small tonnage cost of the rock.

The committee pressed into the question of TVA salaries, demanding a list of all employees getting $3,500 a year or better, with all the raises they have had and the dates on which they were granted. This grew out of a grilling of Gordon R. Clapp, 33 year old director of personnel for TVA. With no previous business experience, it developed, Clapp came to TVA in 1933 for $3,200, and has been raised until he now draws $8,000.

PERSONAL

J. HARRY MOORE of Moncton, N. B. has been appointed associate professor of civil engineering at the University of New Brunswick. Moore graduated from the university in 1933, studied at M. I. T. and Cambridge University, England, and for the past year has been structural designer for the Dominion Bridge Co.

C. LEROUX DUFORT has been appointed registrar of the Corporation of Professional Engineers of Quebec. A graduate of L'Ecole Polytechnic, Dufort practiced consulting engineering from 1905 to 1919. He then entered the Quebec department of colonization, serving for six years as chief engineer of the department. He left the department early this year and was for a short time city engineer of Drummondsville, Que.

C. H. ATWOOD has been appointed director of water resources for the province of Manitoba, Canada.

R. B. NEWMAN, JR., who has been acting chief power project engineer for PWA since the resignation of Kenneth Markwell, last month received a permanent promotion to that position. Newman joined the PWA in 1933, becoming assistant state director of PWA for Tennessee in 1935. When Markwell left the Tennessee directorship to become chief power project engineer the first of this year, Newman became his assistant. Before joining PWA, Newman was chief engineer for the Great Smoky Mountain National Park Commission.

BENJAMIN S. PHILBRICK has been appointed superintendent of construction at Guntersville dam for the Tennessee Valley Authority. Philbrick has been assistant construction superintendent at Guntersville since December, 1935, and earlier was assistant superintendent at Wheeler Dam.

CARL B. WIRSCHING, retired Los Angeles civil engineer, has been appointed chairman of the Public Works Commission of that city.

ROBERT SHAY has been made field engineer with the water conservation corps of the Colorado State Engineers Office.

W. EARLE ANDREWS has resigned his position as general manager of the New York World's Fair. He will act only in a consulting capacity for the Fair corporation, in order to be able to devote more time to his private practice.

MAJOR S. L. DAMON has been transferred from his position as district engineer in Portland, Ore., to the University of Illinois R.O.T.C.

GEORGE E. WRIGHT has opened offices in Corning, N. Y., to practice civil engineering and land surveying. He had formerly been city engineer and superintendent of public works and superintendent of waterworks for the city of Corning.

W. W. MCCLEVY, office engineer in the Virginia state highway department, has been made purchasing agent of the department, succeeding the late George T. Lemmon. C. B. Leech, district engineer at Bristol, succeeds McClevy, and G. Felix, resident engineer at Covington, succeeds Leech in the Bristol district.

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No Negligence Found On Baltimore Tunnel

The explosion of dynamite in the Montebello-Loch Raven water tunnel at Baltimore last month which caused the death of ten men and brought injuries to seven, was held to be an accident by three coroners who investigated the disaster (*ENR*, July 28, 1938, p. 95). There was no evidence of negligence, the coroners found, on the part of workmen or subcontractors. The dynamite, they concluded, exploded while being tamped in the hole previously drilled.

Shortly after this verdict was reached, however, police reopened the investigation in an effort to discover whether possibility of sabotage was indicated by the discovery last week of two loose sticks of dynamite in the tunnel. One was found lying near insulated wire connecting batteries with the engine of a tunnel locomotive, and another loose stick was found in a position where tamping the dynamite might have caused a premature explosion.

State Court Upholds Florida Housing

Florida Supreme Court finds local authority legal and bonds not within city debt limit

Bringing to seven the number of state supreme courts which have upheld state legislation permitting municipalities to participate in the federal housing program, the supreme court of Florida on Aug. 6 upheld the constitutionality of the state housing law.

Handing down its decision in a taxpayers suit which sought to enjoin the Jacksonville Housing Authority from issuing bonds and acquiring property, and the city of Jacksonville from contracting to demolish substandard dwellings, the court held that the housing authority was organized for a public purpose and that slum clearance and low rent housing construction is a public purpose. It follows, the court held, that vesting the power of eminent domain in the local housing authority does not constitute an unconstitutional delegation of power.

Obligations of the housing authority are not bonds within the meaning of that section of the Florida constitution which would require a vote of the freeholders.

The city of Jacksonville may legally enter a binding contract with the housing authority to carry out the elimination of slum buildings, as required by the U. S. Housing Act. The city, moreover, may legally contract with the housing authority to render municipal services to the housing projects, although all real and personal property owned by the housing authority is, the court held, exempt from *ad valorem* taxes.

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Seattle Council Rejects Engineer Reorganization

The Seattle city council has voted down a proposed reorganization of the city engineering department which would have eliminated the positions of chief assistant city engineer and sanitation engineer (*ENR*, July 21, 1938, p. 70). The reorganization, proposed by city engineer C. L. Wartelle, would have divided the city into two districts, with Wartelle in charge of one and Oscar A. Piper, chief assistant city engineer, in charge of the other with the rank of assistant engineer.

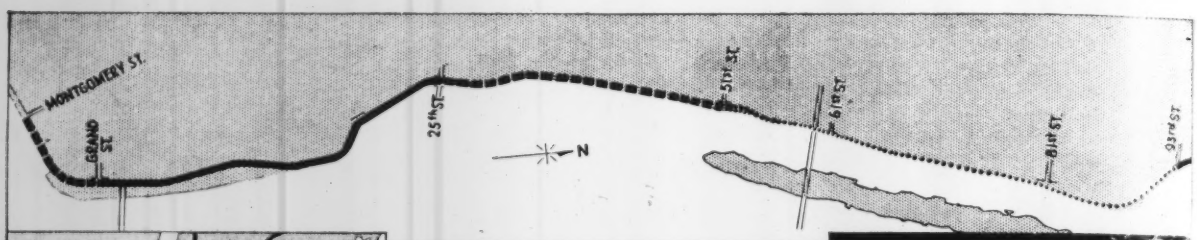
Protests against the reorganization had been filed with the city council by the Engineers Club of Seattle and by Local 17 of the International Federation of Technical Engineers, Architects and Draftsmen's Unions, A.F.L.

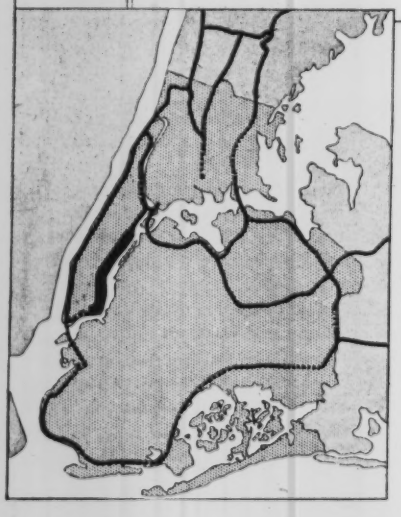
BRIEF NEWS

IN RECOGNITION of its contribution to highway safety, a grand prize was awarded to the Aetna Life Insurance Co. by the international jury of awards at the Paris International Exposition. In addition, a gold medal was specifically awarded for the Aetna Reactometer. The awards were made in connection with the Aetna exhibit at the exposition.

BIDS on state projects in Tennessee, according to a recent regulation of the highway department, will be accepted only from licensed contractors "who have maintained their residence and their office and headquarters in Tennessee for the past two years." The commissioner of highways of Kentucky has ordered that on state-aid projects in that state, bids will be accepted from out of state contractors "under the same provisions as are offered to Kentucky contractors in those states."

THE Cement Reference Laboratory, a joint project of the National Bureau of Standards and Committee C-1 on Cement of the American Society for Testing Materials, is now preparing for a sixth inspection tour among cement testing laboratories. Inspection





New York's New Drive

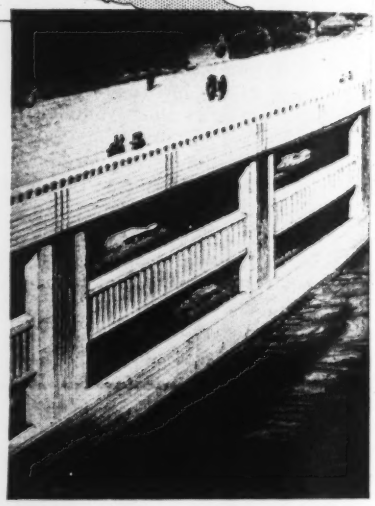
THREE WEEKS AGO PWA made a grant of $4,795,000 to provide 45% of the cost of construction of a long section of the East River Drive, a new express highway running up the eastern shore of Manhattan. New York City offers some of the world's most congested traffic conditions. And yet, if you are going to the right places, it is one of the easiest metropolitan areas in the world to get through. And as the city continues to fill the gap in its network of express highways, the number of parts of the city you can drive to at a steady 40 with no traffic lights and no cross traffic steadily increases.

Shown at the right is the picture that New York City planners have in mind as they lay out new parkway routes. Skeleton of the plan is a great parkway loop circling the city and connecting with through parkways onto Long Island and north through Westchester county to upstate New York. Inside the major loop is a second loop circling the island of Manhattan, where congestion is at its thickest. Solid lines indicate portions of the system completed or under construction, and the dash lines show plans for the future.

Largest project currently under way to close up some of the dash lines is the East River Drive, above, and shown as a heavy line at the right. Swinging from the proposed Battery terminus of the West Side express highway, up the East River to the Triborough Bridge, and thence along the Harlem River to a connection with the tunnel approaches to the George Washington Bridge, this will complete the loop.

The downtown section below Montgomery St. is still only a line on the map. Between Montgomery and Grand Sts. is a section just approved by the city authorities for design and land-acquisition. The completed section from Grand St. north to 14th St. is a six-lane divided roadway with park areas adjoining. Contracts have just been let for paving a similar section from 14th to 23rd Street.

Through the heavy industrial section from 28th to 50th St., plans have been drawn for raising the highway on a viaduct, with the area under the viaduct providing a wide street to service the adjoining docks. This viaduct will come down to grade at 50th Street.



Shown above, as a dotted line, is a section, from 51st to 91st St., which will be put under construction before the end of the year with the aid of the new PWA grant. Plans for this section call for a two-level elevated structure, one deck devoted to northbound and the other to southbound traffic running from 54th to 61st St. This structure, necessitated by the narrow right-of-way available inside the bulkhead line, will be closed on the land side and open on the river side.

Coming to grade at 61st St., the highway will follow the existing Marie Curie Ave., where only minor widening will be necessary. At 81st St., entering Carl Schurz Park, the drive is again on viaduct, this time a three level structure, with the top deck made into a pedestrian esplanade; Carl Schurz Park is being regraded to raise it to the level of the esplanade deck. A small section of land between the drive and the river will be added to the park and connected to the esplanade by stairways. The type of structure in this section is shown at the left.

Returning to grade at 90th St., the Drive, at 92 St., joins the existing approach to the Triborough bridge. This latter, extending up to 115th St., was built by the Triborough Bridge Authority and is now under the control of the President of the Borough of Manhattan, who is carrying out the project, under direction of Walter D. Binger, Commissioner of the Department of Borough Works, of which Lester H. Hammond is chief engineer.

work is limited to physical tests of cements and does not include calibration of compression testing machines.

INTERNATIONAL RAILWAY CO. of Buffalo has applied to the War Department and the Canadian Minister of Public Works for approval of plans of a bridge to replace its Falls View Bridge across the Niagara River, brought down by ice last winter. Foundation excavations on the proposed bridge have been completed on the Canadian side and are nearing completion on the American side.

A LINK with the early days of railroad construction in Canada was broken July 25 by the death of Mrs. L. J. Mainguy, widow of William McL. Mainguy. Mainguy was the engineer in charge of construction of the Canadian Pacific between Thunder Bay and Rat Portage in western Ontario, and Mrs. Mainguy accompanied her husband during this work. She was the only white woman in that part of Canada, and in addition to learning the Indian language, she helped many of the younger engineers on the railroad work with their studies. It is said that among her students were the late J. A. L. Waddell, consulting bridge engineer, and T. J. Kennedy, who later became a well-known Canadian railroad man.

NEW YORK CITY has requested the Interstate Sanitation Commission to place the waters of the upper bay from the Narrows north to Erie Basin in Class A. City officials pointed out that the city is planning to construct a large sewage treatment plant on the Brooklyn shore just above the Narrows and that this, in connection with other plans of treatment, will keep the city sewage out of the upper bay. In order to make this effective, however, they said, treatment will have to be given to the present discharge from the Passaic River.

ACTING at the request of the Pennsylvania Historical Commission, the state attorney-general has authorized the Pennsylvania department of highways to turn over to any interested local group for preservation as a historic relic any covered bridge which does not have to be removed for a highway improvement. In many cases, relocation has made it possible to leave these bridges intact provided groups or persons would guarantee their maintenance.

COUNTIES AND CITIES adjoining those constructing bridges across the Mississippi River in Mississippi would be authorized to share in the cost of the work on the bridge under a bill passed early this month by the House of Representatives of the Mississippi Legislature. The bill would authorize raising of the necessary funds either by issuing bonds or by levying taxes.

A SCHOOL BUILDING program costing $75,000,000 is provided for in legislation now on its way to the Pennsylvania Senate. The general state authority would be authorized to handle the project.

SEWAGE DISPOSAL plants are not self-liquidating investments, the Ontario government has decided, and the province will therefore not make any grants to municipalities in aid of sewage disposal systems.

• • •

Long Bridge Opened In Connecticut

A new bridge across the Connecticut River connecting Middletown and Portland, Conn., was formally dedicated on Aug. 6 to the accompaniment of ceremonies which included a land and a marine parade.

Built at a cost of $3,500,000, the 3,420-ft. bridge includes two tied steel arches each 600 ft. long, resting on three granite piers.

The new bridge was planned and erected under the supervision of the Connecticut state highway department. It was financed by a Middlesex County bond issue, which will be retired by payments from the state highway department.

• • •

Connecticut Dump Trucks Not to Be Regulated

Dump truck operators hauling excavated materials on road and building projects do not come under the jurisdiction of the Connecticut Public Utilities Commission, the commission has ruled. Under the new ruling, dump truck operators, who have previously held common carrier or contract carrier licenses, will not be required to take out permits.

The ruling of the commission in effect denied a petition brought by the Connecticut Dump Truck Owners Association that the commission set minimum rates for common carriers in this service.

Transportation of excavated material, the commission held, is not affected by a public interest as regards service and rates. It is held to be a particular and contractual service rather than transportation for hire in the movement of products in commerce.

Much Road Work Now Under Way

Delay in federal-aid allotments increases volume of summer construction

Highway construction is proceeding more rapidly this summer as a result of the delay in making federal-aid allocations to the states. Allocations usually made the first of the year were not made until March 28. Time lost during the first quarter is now being made up. This is shown by reports received at the headquarters of the Association of State Highway Officials.

Nearly $65,000,000 was put under contract by the state highway commissions during the first six months.

Funds actually paid out by the Treasury on highway contracts during the first half of the year were as follows:

January	$11,700,167.57
February	6,676,759.78
March	6,569,479.66
April	6,962,556.70
May	8,650,792.80
June	11,902,313.76
TOTAL	$52,462,070.27

In addition relief expenditures were made in the following amounts:

January	$4,894,007.47
February	5,708,518.97
March	3,623,428.64
April	3,539,403.89
May	3,741,649.76
June	3,030,476.11
TOTAL	$24,537,484.84

The Treasury expects to pay out more money for highway construction during the last six months of the year than during the first half of the calendar year. Disbursements in July were $15,000,000 under specific appropriations, it is estimated. In addition some $4,000,000 of relief funds were used for highway purposes.

Despite the reductions that have been made, highway construction still continues to contribute to employment and toward providing markets for materials and equipment. During the fiscal year ended June 30 more than $235,000,000 of federal money was paid out for highway construction. This was a marked reduction from the fiscal year ended June 1937 when federal expenditures were slightly more than $350,000,000.

• • •

State Pays Engineering

The Attorney-General of Connecticut has ruled that the state highway department must pay engineering expenses on WPA town road projects. He pointed out that the state highway department has appropriations to pay engineering costs on town-aid roads and pays such costs where state funds are used for construction.

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Marking Test Piles

Sir: We are interested in discovering a proper device for marking test piling on bridge projects before driving.

In driving a test pile of either concrete or treated timber material, it is necessary that the number of blows per foot of penetration be determined. This requires that at least 25 or 30 ft. of the pile be marked at 1-ft. intervals, and the marks identified as to their distance from the point of the pile.

We have been considering the possibility of securing stencils, either in roll or strip form, which may be accurately attached to the piling, and the required marks and numerals applied with paint. A marking roller has also been suggested, but the surface of the piling is not always smooth and there is a possibility that the roller might slip.

If a satisfactory device can be developed we hope to be able to specify its use on state highway work, providing the device will be easily obtainable by the contractors.

Any suggestions which you readers can offer in regard to this problem will be most welcome to us.

HERBERT ELDRIDGE
Acting Bridge Engineer
Texas State Highway Department
Austin, Texas

Engineering Graduates

Sir: In the July 14 issue of *Engineering News-Record*, p. 37, there appeared a news report of statements by W. S. Conlon, executive secretary of the National Society of Professional Engineers, attacking Case School of Applied Science for publishing the facts concerning our placement record for this year.

Case School of Applied Science has never made a promise of employment to any student either orally or in any of the printed publicity material sent out by the college. In the published report which Mr. Conlon attacked no mention was made of any promise or any obligation on the part of the college to find jobs for its graduates.

I do not think that those engaged in engineering education believe that every student who attends an engineering college will follow the profession for his whole life. We speak of this as the age of science and yet Mr. Conlon pleads for restriction of the number of those who are being trained to carry on and advance our age. Perhaps we should also restrict the number of art students, musicians, architects and teachers, for those professions are also overcrowded. We here at Case see the growth of industrial science as a sign of expanding opportunity for the engineer. It is true that it is not the same type of opportunity which existed 25 years ago, but the opportunity is there.

Such fields as personnel administration, sales engineering, patent law, industrial management, and government service are just being opened up to engineers and it is being recognized more and more that engineering training is almost a necessity for success in these types of work. The recent appointment of Mr. Andrews, an engineer, to administer the Wage and Hour Bill, is an encouraging sign.

Mr. Conlon's statement that industrial concerns are on the lookout for low-cost engineering services is certainly contrary to fact. The young man who has just finished a four-year course in engineering is not by any means an engineer. All he has to sell to an industrial employer is potential ability and the development of that ability by company training courses is an expensive undertaking. The first few years the student may be worth little to the employer who is investing money in him and keeping him on the payroll with the expectation that he will prove valuable to the company later on. This could hardly be called exploitation. Further, Mr. Conlon's statement that there is a constant turnover with these young men is certainly contrary to our experience.

J. J. MOORE
Placement Representative
Case School of Applied Science
Cleveland, Ohio, July 30, 1938

Algerian Dams

Sir: We have read with great interest Mr. I. Gutmann's article on Algerian dams in your issue of May 26. However, in our capacity of representative for France of K.L.M. processes of injection of chemical products, we should like to draw your attention to an error which your collaborator committed. The injections in the dam of Bu Hanifia did not permit of the application of K.L.M. processes. They were done by one of our confreres by application of processes which belong to him.

The work in the North of Africa which we sealed by injection of cement and chemical products, applying K.L.M. processes in this instance, is the Zardezas dam in Algeria.

P. BACHY
Enterprise P. Bachy
Kremlin Bicetre, France, June 14, 1938

Stresses in Plywood

Sir: In the article on Laboratory Tests on Structural Plywood (*ENR*, June 16, 1938, p. 855) the writer neglected to state that compressive, tensile and flexural unit stresses were computed using the entire cross section of the plywood. Since the areas of the cross plies are sometimes omitted in making computations it would seem desirable to clarify this point.

HARRY A. WILLIAMS
Assistant Professor in Civil Engineering
Stanford University
July 5, 1938

Everyday Concrete

Sir: I have read, with considerable interest, your editorial on "Everyday Concrete" (*ENR* July 13, 1938, p. 43) and am not at all surprised at the variation found in the so-called "everyday job."

You look to research for the answer. Isn't the answer right at hand in applying the "concrete control" to the everyday job that is applied to the large job. This "concrete control" means substantially two things: (1) an experienced concrete supervisor and, (2) testing equipment.

On the large job, supervision forces and laboratory facilities can be organized or, as is quite generally done, the facilities of an independent inspection and testing laboratory, with concrete superintendents from such organizations, are used. On the everyday small job, the first plan is

impractical, but the second is not since there are independent inspection and testing organizations throughout the United States whose services are available, even though the job is so small as to require only a day's concreting.

In your editorial you suggest the development of field tests that will give a quick and typical check on the concrete quality. This, even if quick, is too late for the average everyday concrete. The end desired is accomplished by having a competent inspector setting the mix and controlling the mixing and placing of the concrete; the test cylinders simply check the performance of the inspector.

I can quite confidently state that the cost of proper concrete supervision and testing will not be more than the cost of the additional concrete that would have to be placed if working stresses were reduced to take care of non-uniform concrete.

Furthermore, the quality of concrete obtained under "concrete control" will have a durability that is considered by many to be more important than the strength.

H. H. MORGAN
Robert W. Hunt Company
Chicago, Ill., July 22, 1938

Lateral Resistance

Sir: In the interesting article by A. Floris, (*ENR* July 14, 1938 p. 59) is presented a practical analysis of the lateral resistance of multiple-story structures.

The usual assumption of rigid frame action which involves bending moments in the beams does not agree quite exactly with the observed conditions of structures which have been subjected to severe lateral forces of wind or earthquakes as noted in *ENR* Oct. 14, 1926, in connection with the Florida hurricane.

A practical approach to the solution of the difficult problem of wind and earthquake stress analysis, where concrete floors are inherently stiff and act as diaphragms, is to consider the columns in each story fixed at both ends, acting independently of the columns in other stories as suggested by Mr. Floris. An advantage of this method is that the deflection of the top of the building can be determined expeditiously, being equal to the sum of the deflections of the stories below. The story deflection is computed by the well-known formula $\triangle = \frac{1}{12}\frac{Hh^3}{EI}$ where H is the shear at the top of the column and h is the story height.

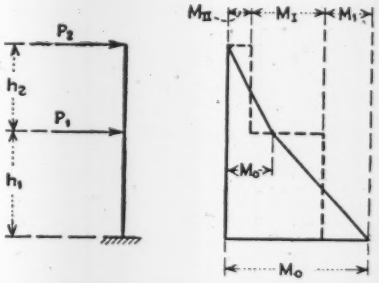
The method of analysis as outlined by Mr. Floris is valuable as a supplement to the more elaborate theories now in use. Structures constructed of thick flat slabs can be analyzed preferably by this method.

R. McC. BEANFIELD
Consulting Engineer
Los Angeles, Calif.

Sir: It might be of general interest to note how Mr. Floris' equations (2) (*ENR* July 14, 1938) reduce to something readily usable when one solves for expressions of M_I and M_{II}.

$$M_I = \tfrac{1}{2}[(P_1 + P_2)\ h_1 + P_2 h_2]$$

$$M_{II} = \frac{P_2 h_2}{2}$$



The moments for Mr. Floris' Fig. 4 and M_I and M_{II} may be shown as follows:

M_2 is numerically equal to M_{II} or $\frac{P_2 h_2}{2}$ and M_1 is numerically equal to $M_I - M_{II} = \frac{1}{2}(P_1 + P_2)h_1$. Now these expressions are the same as one would obtain by using the shear at mid-height of column times one-half the height of column for the moments at top and bottom of column.

If there are several columns in a given story then this total shear at the story should be divided among the columns in proportion to their $\frac{I}{L^2}$ values.

ROBERT B. B. MOORMAN
Assistant Professor of Civil Engineering
University of Missouri

Merritt Parkway Bridges

Sir: Since my article on the Merritt Parkway bridges was published (*ENR*, Sept. 23, 1937, p. 501), certain changes in the design of the more recent structures have been made, which may be of interest.

It will be recalled that the Merritt Parkway is of dual type, having two 26-ft. lanes separated by a grass plot, usually 21 ft. wide. At bridges, both over and under the Parkway, the lanes are converged by reducing the width of the central grass plot to 16 in. (the width of the two center curbs). However, since the bridge widths and spans are 60 ft., the actual width of the lanes is increased at the bridges from 26 ft. to 29 ft. 4 in.

In spite of this increase in lane width, some criticism of the convergence of the lanes arose, and the department has altered the design on the more recent bridges to meet this criticism, although not agreeing that the original arrangement lacks any of the elements of safety, economy or appearance.

The design revisions have taken the form of increasing the width of the dividing strip at bridges to a minimum of 8 ft. and narrowing the pavement lanes to 26 ft., as obtains elsewhere on the road. To provide additional side clearance, back of the curbs, the faces of abutments have been moved back 4 ft. 8 in. on each side. Thus the new bridges will have less available travel-path area but more clearance outside of the traffic lanes than the old bridges. Of the 14 bridges remaining to be built to complete the parkway to a point north of Bridgeport, six will have an 8-ft. grass plot, on five the grass plot will be 21 ft., while the remaining three will be 12, 15 and 30 ft., respectively. The wider strips are for two span bridges for which a minimum center strip width of 21 ft. has been established.

A further revision, and one which is conceded to be a safety improvement, is to move the usual rather high curb on bridges away from the edge of the travel path and mark the latter by some type of low curb. The space between the low curb and high curb will be covered with loam, grass, bituminous material or concrete of a different color from the pavement proper. The principal advantage will be to outline clearly the edge of the travel path without erecting anything high enough to cause drivers to edge away from it into the adjacent lane. To provide the several additional feet of width necessary will increase the cost of the bridges, but the psychological effect on the driver may well be worth the added expense.

L. G. SUMNER
Engineer of Bridges and Structures
Connecticut State Highway Department

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Editorial Offices at 330 West 42nd Street, New York

AUGUST 11, 1938

IT MIGHT BE difficult to select the drainage basin which presents the nation's No. 1 pollution problem, because conditions are bad in so many of them. However, any list of the leading problems would include the Hudson River area. Its condition is revealed in an article on p. 181, which summarizes recent studies. They show that in order to end the degradation of the river it is essential for all communities in the basin to end the discharge of raw sewage. In other words, the responsibility for a river cleanup is laid squarely on the doorstep of every town, village and industry. Each has a part to play, and without united action pollution abatement cannot be realized. Excuses for non-cooperation because of lack of money have little substance now when federal financial aid is being so generously supplied to further sanitation improvements. And public officials who fail to take advantage of this situation may soon be called upon to answer for their negligence. With the intensive drive by health authorities to end river pollution the time is not far distant when court orders will replace pleas for cooperation.

How the Customers Feel

AT THE OPENING of the new Connecticut River bridge at Middletown, Conn., last Saturday an assemblage of visitors that by some estimates reached 50,000 was gathered to witness the event. The countryside for fifty miles around sent delegations of paraders or spectators, and the affair was made a gala occasion. Barring the chance that this merely proves a strong appetite for celebrations on the part of the Nutmeggers, the bridge-opening festivities visibly expressed the satisfaction of the bridge users at obtaining a new facility and convenience. The low bridge that did duty for 42 years (except when the draw was open or the roadway was submerged by floods) has long been out of match with transportation demands, and when a modern trouble-free crossing was made available the customers could not help but rejoice. Public works officials everywhere will be well advised to take notice of this feeling. It is a measure of the popular demand for improvements that give better community service and save discomfort, delay and expense. If any public officials believe that their communities have enough improvements they ought to test their ideas by measuring the public demand before using them as a basis for administrative policies.

Watch Your Flashlights

A PREMATURE EXPLOSION in the Boston Water Tunnel in 1931, resulting in several fatalities, was attributed to electric detonating cap wires coming in contact with a metal-case flashlight. Following this accident Frank E. Winsor, chief engineer of the Metropolitan Water Supply Commission of Boston, specified the use of safety flashlights with fiber case, impossible to short-circuit through the switch. Sensible as it is, this safety precaution is rarely incorporated in tunnel specifications outside Boston. It is highly desirable to include it in every specification for work involving use of explosives. Yet, common sense decrees that use of safety flashlights should not depend upon specification requirements. Every chief inspector should see that the engineers are equipped with these safe lights; every contractor should see that no other type of light is permitted around explosives. The recent tragedy at Baltimore, as yet unexplained, is a grim reminder that premature explosions are ever a hazard. The possible causes of such accidents can be reduced by one, through elimination of unsafe flashlights.

Design by Models

THE RAPIDITY with which change occurs in civil engineering practice, introducing new design tools and creating construction jobs, is well illustrated by the recent spillway improvement program on the four Salt River dams in Arizona, which originated in studies of models in a laboratory. A decade ago, prior to the design of Boulder Dam, model studies were not a part of American dam design practice. Thus, despite the fact that three of the four Salt River dams are less than 15 years old, their spillways were designed by analytical methods only. And, in operation, they did not prove to be satisfactory. Check-up by models two years ago revealed that their discharge capacity was only about 60 per cent of what the analytical design had attempted to provide, a condition that required remedy. Model studies were again resorted to, and, by trying numerous spillway and gate arrangements, designs were worked out that brought the structures up to par. Four spectacular construction jobs resulted, and the dams are now ready to function as designed. In a short space of years a laboratory plaything had changed the course of engineering procedure. It has happened before and it will happen again in the steady search for knowledge that will assure safer and better structures.

Multipurpose Reservoirs

BUCHANAN DAM above Austin on the Colorado River of Texas is the center of a heated controversy as the result of wide flood damage both above and below the dam. Property owners above the dam whose land was inundated when flood waters from upper tributaries caused a sudden rise in the newly formed lake claim that an abnormal amount of water had been held in the reservoir for power purposes, that had the lake been low no flooding would have resulted; landholders below the dam claim that water was released from the reservoir too rapidly, to make room for the expected inflow, thus doing more damage to their land than would have occurred had there been no dam.

It is too early to know how true the charges are. The Lower Colorado River Authority, which took over and completed the dam and is building other dams as part of its program of water conservation, flood control and power development, maintains that the charges are unfounded and are propaganda against the authority spread by the private electric utilities with which it will compete. To settle the matter of whether the reservoir was improperly operated the state legislature has begun an investigation and Secretary Ickes has sent Harry W. Bashore, one of the able engineers of the Bureau of Reclamation, to report on what happened.

Regardless of the outcome of these investigations, the incident serves to emphasize the problem which is raised by any multipurpose dam and to point to the need for the most competent and impartial control of such structures. The chairman of the authority states that conservation and flood control are on a par under the law creating the authority and that storing water with which to generate power is an essential function of the authority. He stated also that sale of power is necessary to amortize the cost of the project.

In this as in other like situations it is natural to expect that regardless of the terms of the state law, power will get first consideration because it brings a cash return, which is not the case with flood control. Somewhat similar is the experience of the Bureau of Reclamation, which has records of undue drafts having been made on stored water which it did not control to generate power during winter months because the irrigation district needed cash, only to find that there was not water enough for the irrigation requirements of the following unusually dry summer.

Generally speaking, in operating a multipurpose reservoir, water control for flood protection and conservation comes first; power must be secondary to both conservation and flood control. But except on irrigation projects where water for each season's crops is vital to the community, power is apt to advance to first place in the interest of the operators. It is what farmers call a cash crop, hence the ever present temptation to fill space that should be reserved for flood storage with water that can be turned into power.

We are only now beginning to plan for and build a multitude of multipurpose reservoirs under public auspices, largely on the assumption that flood control on our large rivers is a national responsibility, but already it is evident that the planning must include control of water storage and use that is free from temptation to convert flood storage into power storage. In the case of organizations like the Colorado River Authority or the Tennessee Valley Authority, it would seem essential that supervision of storage be placed under a state water board or the state engineer. On navigable streams such control should rest with the army engineers. This would insure closer adherence to a safe plan for the use of available storage and at the same time would free the authority of such charges as now embarrass the operators of Buchanan Dam.

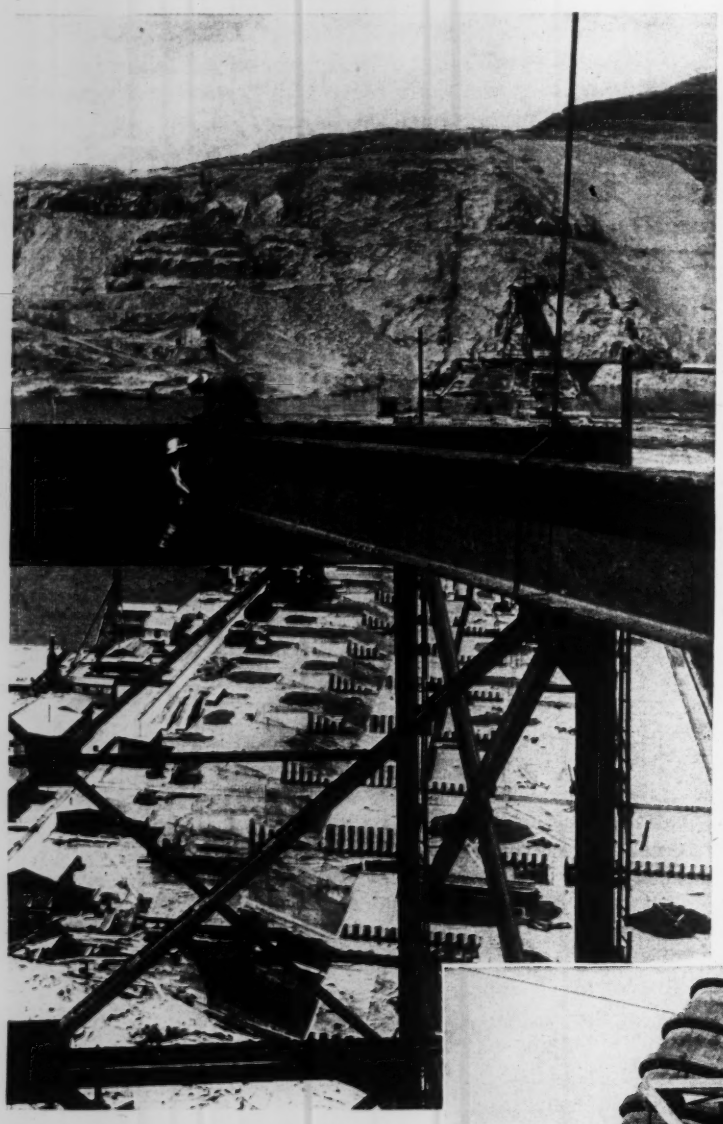
Why Monolithic?

THIS WEEK'S ACCOUNT of experience with dummy-joint construction in the long concrete walls of a Bellingham, Wash., school building calls to mind a question that is becoming more and more insistent as experience with concrete accumulates. Is concrete construction actually monolithic? And if not, should we design and build concrete structures as though they were integral monolithic units?

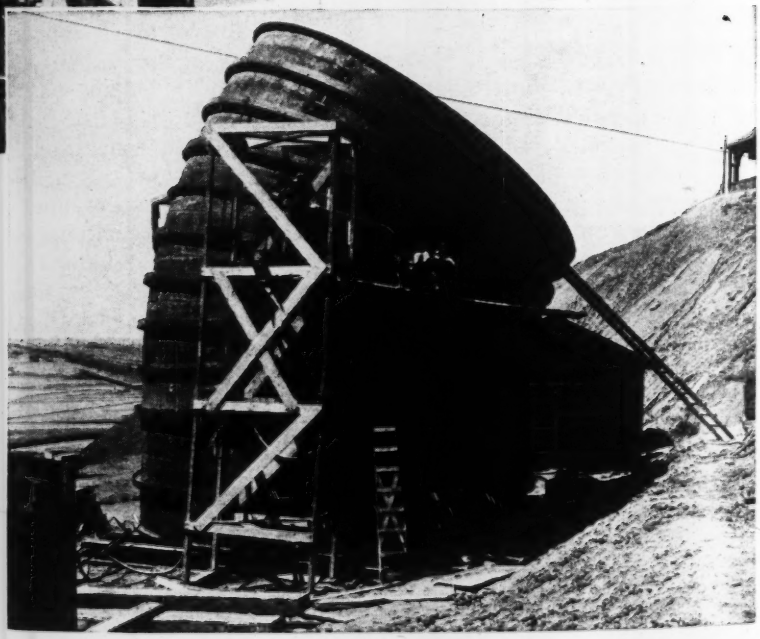
Practice, as a matter of fact, long ago has allowed for the tendency of concrete masses to break up into smaller units. The roadbuilder provides frequent expansion and contraction joints in his pavements; the dam-builder divides his construction into slices or blocks by planes of separation. But these expedients are used in spite of rather than because of conventional doctrine; the beginner is still taught to regard monolithic construction as the ideal, and most designers continue to shape their work accordingly. Yet even in the first few days after concrete is poured its heating and cooling break the supposedly monolithic mass into irregular blocks, and subsequent shrinkage as the concrete sets as well as movements caused by moisture and temperature changes lead to further separation.

Systematic provision for this subdividing tendency paid well in the Bellingham case, and a year's experience there indicates that even more thorough contraction jointing would have been worth while. The underlying idea is one that has application to all concrete construction.

PICTURES IN THE NEWS



TRESTLE FOR GRAND COULEE. Workmen assemble the east approach to the new 3,600-ft. steel trestle that is being built 180–205 ft. above present concrete. Intended to carry concrete trains, the trestle will be 47 ft. wide and will have four tracks.



AND AT FORT PECK this huge section of steel pipe forms part of the connection between the 24-ft. diversion tunnels and one of the four 50-ft. control shafts.

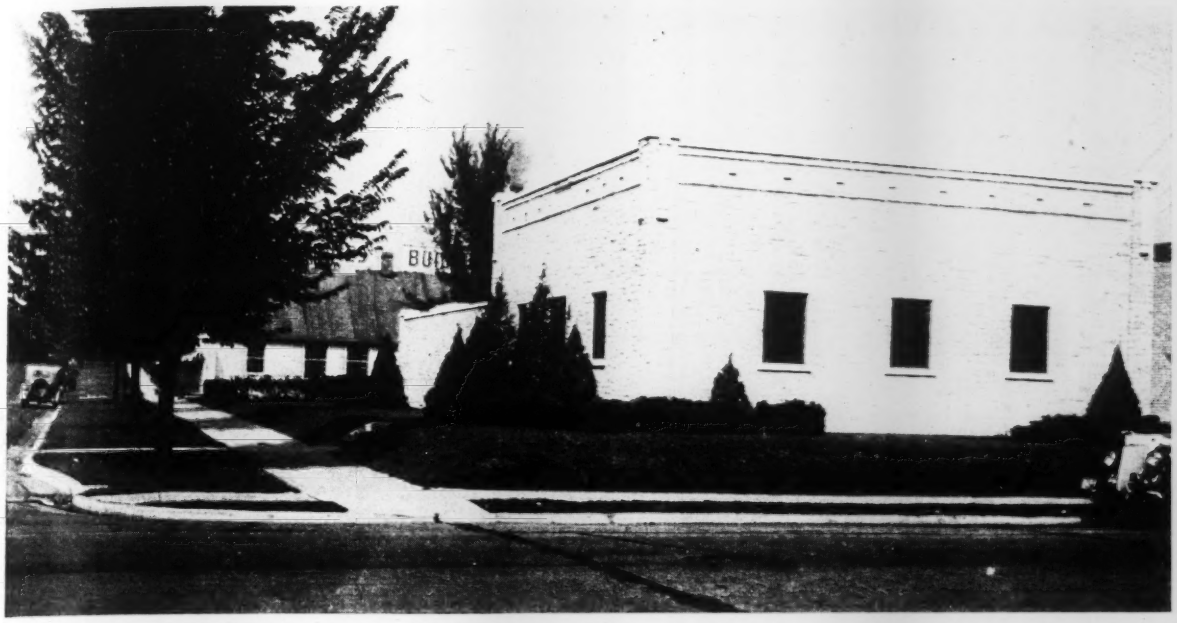


FIG. 1. ONE OF MADISON'S UNIT WELL STATIONS IN WHICH ARE MOTOR-DRIVEN CENTRIFUGAL PUMPS

Reliable Water Service

W. W. De Berard

Associate Editor, *Engineering News-Record*, Chicago

The fast developing university city of Madison, Wis. keeps its supply system modern by new feeder mains, close inspection service, new meters and careful records

For the last quarter of a century Madison, Wis., has been growing roughly 50 per cent every decade. In consequence the principal water problem has been to maintain reliability as to quantity and service under ever-increasing demand. Only this year has the superintendent felt easy, since the ten-year program of improvements projected for 1930-40 has been completed. He is now able to give more attention to efficiency refinements in operation; not that Madison has been in the inefficient class, but there are always places where costs can be cut and more business taken on, even in a municipal plant.

A citizen water commission appointed by city council has run the system since the initial plant was built in 1882. Bringing the water service up to the present high standards for this capital city of 65,000 people has involved such items as distribution system strengthening, valve and hydrant spacing, accessibility and inspection, meter replacements by which revenue was increased, metering of all public uses to reduce losses, and locating and recording anew all mains, hydrants, valves and service boxes. To find out how these items are handled so as to bring Madison toward the top in the underwriters classification and provide a satisfactory domestic service at low cost was the main objective of a recent day's visit with Leon A. Smith, superintendent since 1916.

The city's supply

The system is supplied from wells drilled 750 ft. to Potsdam sandstone down through other sandstone aquifers found within 50 ft. of the surface. The Potsdam outcrop is in the vicinity of Wisconsin Rapids; as the rate of percolation is 1 in. per hour, it appears that the water now being pumped fell as rain 2,000 years ago. Airlifts raise the water to reservoirs near the wells, whence it flows by gravity to the main station or is pumped directly to the mains. A 6-m.g. circular concrete reservoir on the highest hill in town rides on the system, being filled at night and drawn down some 5 ft. during the day to equalize pumping operations. The 85-lb. pressure maintained at the main pumping station will put water on the top of every building in town. The water is pure bacteriologically, not a single positive B.Coli identification having been obtained for a dozen years, but it has a hardness of 18 to 20 grains per gallon.

Some 300 customers in two small areas are furnished with booster service by centrifugal units having flat

efficiency curves—100 and 600 g.p.m. capacity respectively. These pumps are in 12x16-ft. pits in the street alongside pneumatic tanks, now abandoned along with the former pumps having sharp efficiency curves; the frequent starts and stops wore out the equipment unduly.

Stations are all well groomed inside and out. It has been found that 8 per cent added to the cost of bare utilitarian requirements will produce a plant of which the citizen can be proud as a civic asset. Recently, sod was purchased from a sheep pasture at ¼c. per sq.ft. for station grounds. Maintenance of super-lawns has produced business, since people seeing the fine results at the water stations call up to learn the secret of lawn building and maintenance.

Madison is located in a glacial drift area, on the surface 40 per cent being sand and gravel, 40 per cent clay and 20 per cent mixture. The clay stands well in trenches and the sand is stiff enough so that little sheeting is used, but trench walls are usually sloped. In about 80 per cent of the city's area good digging is encountered; in the remainder large boulders are a problem. Some boulders are buried or moved to one side. Others are shot, but in congested districts blow-torches are often used to split them.

Past practice as to cover over the top of the pipe has been 6 ft., to get below the depth of frost penetration. The extreme cold of the winter of 1935-36 penetrated deeper than 6 ft. in some spots; particularly noticeable were freeze-ups under sidewalks from which snow had been removed.

Distribution and valves

All of the 145 mi. of mains are of cast-iron pipe, 3 to 30 in. in diameter. The water is non-corrosive; pipes laid in 1882 are still in first-class condition. The layout is the gridiron system, mains being laid on all four sides of the interior blocks and cross-connected at all intersections. Usually the location is 5 ft. from the center of the street on the south and east side. Locations are determined by the city engineer. At present the 6-in. size is minimum, but many miles of 4 in. pipes were laid in the early days. These small lines have been paralleled by feeder mains in many streets, laid out to form large loops and to connect the pumping stations, reservoir and outskirts. Some 16 mi. are outside the city limits. There are 15 mi. of feeder mains reinforcing existing lines and 5 mi. of single lines, 10 in. and over in size.

The distribution system is well sectionalized, with 2,500 valves and 1,200 hydrants. It is the aim to have these valves at every intersection and so arranged that no more than a single block would be shut off with any one valve broken or shut down for repair or inspection. For this purpose there are three valves at every intersection except for 60 locations, and here no more than two blocks will be affected by a break.

Hydrants are installed at every corner of the 660-ft. blocks of old platting and of the 500-ft. blocks of the more recent subdivisions. In long blocks hydrants are set in the center. In streets adjacent to the capitol square, in the high-value district, two hydrants are set on diagonal corners. Sizes are 4- and 5-in., on 4-in. and 6-in. branches respectively. All 6-in. branches have valves; the smaller branches are to be valved eventually.

Back 10 years ago the city had an annual $250,000 program of paving, and many valve boxes were covered at that time. It was easiest to screw down the box and fill over it. Some 60 have been found, dug up and provided with manholes.

Inspection of both hydrants and valves is taken seriously in Madison. Never in 30 years has the fire department unexpectedly found a hydrant unusable. Notice is given the fire department if a hydrant is out of commission for any reason. All valves are inspected at least every other year; that is, each year half of the entire installation is inspected. In the high-value districts many more inspections are made. When inspecting a valve the inspector makes sure that he can get the key on the stem in the box. As he opens the valve he counts the turns, then he closes the valve and notes whether the packing is O.K. If it is a geared valve he lubricates the gears with graphite grease. He makes only minor repairs, but supervises such others as require assistance of additional help. For 20 years Madison has had a full-time inspector.

Every fall and spring every hydrant is inspected; many of them are inspected more often. Inspection consists of opening, to see that it works easily, flushing, closing, cleaning, packing if leaking, and lubricating. Finally the inspector sees that the drain hole is open.

Meter practice

The city furnishes all meters, which on the consumer's premises are located on a shelf on the basement front wall, 30 in. from the floor, with a control valve on the inlet side. Percentage of water sold to customers has risen, public consumption has decreased and unaccounted-for water has decreased since a definite drive was started to conserve water and get paid for all of it possible.

In the first place 1,000 meters older than 20 years were junked in 1929, and again in the next year all meters older than 15 years (some 2,000) were discarded. Thus at present all meters are less than 21 yr. old. A program to bring to the shop all meters at least once in 4 yr. was inaugurated but was found unnecessary two years ago when a group of 50 meters was brought in; only two of these did not register within the 2 per cent tolerance permitted by the Wisconsin Public Service Commission. This fine record led Mr. Smith to the conclusion that the 4-yr. period is too short. After test and repair, meters are set to read between 62 and 63 lb. for 1 cu.ft. of water.

On a 1/32-in. stream, meters not only must register but must be within 90 per cent of accurate. Since this requirement was made revenue has gone up. Before this degree of accuracy was obtained a canny Chinese laundryman found he could draw two tubs of water overnight by a small stream without moving the meter. Another reason for the junking program was to reduce the parts inventory. For the 28 types and makes it formerly required a $1,000 inventory and now, with only 4 kinds left, an $800 stock is sufficient. Gear trains of the types used are oil-inclosed and nickel-bronze is used in disc chambers.

Meters in Madison invariably run slow after use, giving the customer more water than he pays for. In case of plumbing leaks the bill is adjusted on the basis of the customer paying his regular bill as estimated from past consumption, the remainder being billed at the lowest step in the rate schedule. The reasoning follows a ruling of the Public

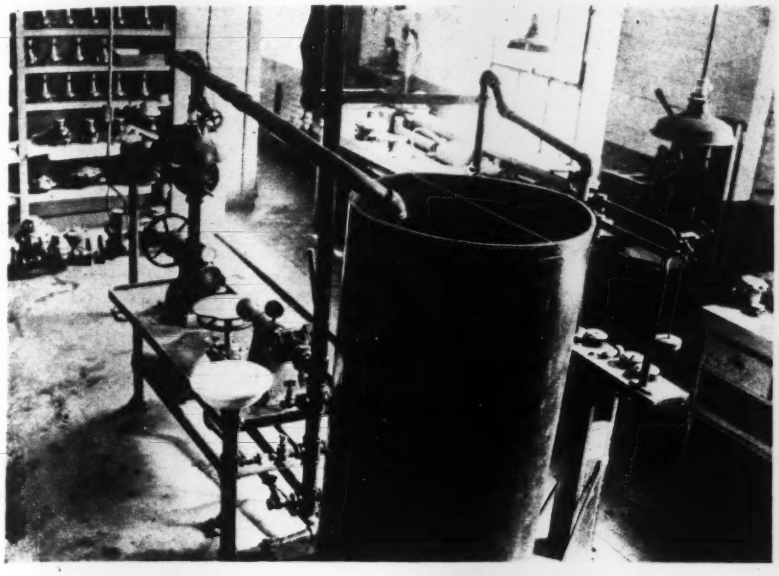


Fig. 2. Meter testing outfit for Madison Water Department.

Service Commission which says that the customer shall pay actual cost, which is about one-half the regular charge; thus no part of the waste has to be borne by other consumers.

In figuring on necessary capacity, which the system now has, Mr. Smith estimates roughly an 8-m.g.d. average use; double this, or 16 m.g.d., the maximum day's use; and 8 m.g.d. additional for fire-fighting on the maximum day, making 24 m.g.d. as the rated capacity needed.

The consumption of water in Madison is about 120 gal. per capita. Of this 83 per cent is registered by the consumers' meters, 6 per cent is public consumption such as street sprinkling, fire protection, flushing sewers, etc., 5 per cent is flushing hydrants and station uses, and 6 per cent is unaccounted for. This last figure has been cut from 23 per cent in 1918. A decided cut was noticed after meters were placed on all services for public uses. The unaccounted-for water is lost through under-registration of the 5,000 meters, leaks in the distribution system and an inaccurate check on water used from hydrants.

In making the reduction the first thing that was done was to check completely all of the meters in the distribution system. It was found that there were 3,000 meters which were over 20 years old and which could not be made to register accurately on all streams. As noted above these 3,000 meters were junked in 1930 and replaced with new meters. Meters are checked when their consumption exceeds 100,000 cu.ft. Whenever a meter inspector finds a meter stopped, a stop card is made out and the meter is replaced at once. To eliminate leakage in the distribution system it was found advisable to have a water-waste survey made. This survey developed many leaks and several cases of unauthorized use of water, all of which were corrected.

At the present time a close check is kept of the distribution system and every leak is promptly reported and repaired. A close check is kept on all building permits and all contracts let by the city, so that a definite arrangement can be made with the contractors to insure payment for the water used during construction. The output cost of water is about 5c. per 100 cu.ft., as compared with 6½c. in 1918, so that the reduction in the unaccounted for water has been an important item in the cost of water sold.

Meter inspection

The department has three full-time meter inspectors, together with a general inspector, and all meters are read at least every two months, the larger meters being read more often, depending upon the quantity of water used. The meter inspectors, in addition to reading the meters, keep an accurate record of all leaks which they find, either in the distribution system or in the plumbing fixtures in the homes. Leaks in the distribution system are reported to the service foreman and are promptly repaired. Leaks in plumbing fixtures in homes are reported to the owner or tenant so that an opportunity is provided for prompt repairs, thus preventing water waste and large bills.

The general inspector reports at the office the first thing in the morning and afternoon, and is the outside contact man of the office with water consumers. He checks meter readings, makes inspection of plumbing fixtures in homes, collects bills and keeps track of the water used for construction. He is provided with an automobile for this purpose.

Location survey and record

Since the advent of relief projects Mr. Smith has initiated several surveys to locate the exact position of mains, valves, hydrants, services, and stop boxes. These locations eventually find their way onto a large drawing in the city engineer's office and thence to the "Black Book" (the covers are black) which is a loose-leaf binder for 8x13-in. photostat sheets which it is estimated would cost $30,000 to duplicate. Copies are supplied to the superintendent and street foremen.

Meter histories are kept on 4x6-in. cards cross-indexed by meter number and house numbers on various streets. Original costs, subsequent repair data, costs and dates are included.

A complete, modern system of records and accounts has been installed in each division of the water department and the following reports are presented to the superintendent monthly: *Chief engineer:* pumpage for the preceding month, together with total and unit costs. *Service foreman:* complete information as to services installed and maintenance work. *Storekeeper:* record of supplies received and disbursed, as well as the mileage and cost per mile of truck operation. *Chief clerk:* number of meters set and removed during the preceding month. *Accountant:* status of the water fund. *Bacteriologist:* the results of the bacteriological analysis of the city water.

In addition to these records a daily record of boiler evaporation and cost of pumping is kept which is available to the superintendent on the succeeding day. In this way close attention can be given to costs and there is a constant checkup on the

efficiency of operation. If any unusual situation develops this fact can be ascertained and the condition corrected before it seriously affects the operating costs.

Research and finance

Two years ago the water department definitely started an active research project, having in mind general improvement in the quality of the water, developing facts which would result in the sale of additional water, and various other items of better service to the consumer. This work was done with the cooperation of various departments at the University of Wisconsin, particularly the state laboratory of hygiene and the department of hydraulics and sanitary engineering, with some work done by students as thesis work. Such students on occasion are furnished with quarters at the unit well pumping stations.

Roughly the net worth of the plant is $3,000,000 and the funded debt is $150,000. The water department operates as a separate utility paying interest of $91,000 (being 4½ per cent on the equity which the city has in the plant), taxes to the city of $39,000 (the same as would be paid by a private company), and $30,000 toward amortization of the city's funded debt for the water department. The total income is $400,000. Operating expenses run $175,000, leaving $30,000 for depreciation and in addition a $35,000 balance to be reinvested in the plant.

The meter rate is 7½c. per 100 cu.ft. for the first 75,000 cu.ft. and a semi-annual demand charge for a ⅝-in meter of $2 for each customer. Customers outside the city limits pay 33 1/3 per cent more than those inside the city.

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Solar Power Subject of M.I.T. Study

AN EXHAUSTIVE RESEARCH into the power possibilities of solar energy used directly will shortly be launched at the Massachusetts Institute of Technology as a result of a $647,700 gift by Dr. Godfrey L. Cabot of Boston. The program is being planned for a 50-year development of the subject, and the laboratory, staff specialist roster and scientific resources of the Institute will be used.

Unbalanced Road Intersection

Indiana experiment provides extra lanes for right and left turns with offset center curbs

WHERE U. S. Routes 30 and 41 cross in northwestern Indiana a new type of road intersection has been installed as an experiment by the Indiana state highway department. Both routes carry heavy traffic, and the intersection marks the western end of a new dual superhighway cutoff just completed on Route 30. A clover leaf or some other type of grade separation would have been prohibitive in cost, and lack of funds to reconstruct grades on Route 41 ruled out consideration of a traffic circle. Yet the engineers decided that some special treatment was necessary because of the heavy traffic passing through the intersection.

Consequently they worked out an unbalanced crossing in which all approaches to the intersection are four lanes wide; all exits are two-lane width. On the approaches this provides an extra center-lane for left turns and an extra right turn lane, the latter widened out by a 75-ft. radius curve. Opposing lines of traffic in the approaches are separated by strips 5 in. high and 3 ft. wide.

The intersection is controlled by traffic-actuated lights at the four corners and overhead center. Contact plates in the approach lanes operate the lights for stop and go. Left turn, through and right turn traffic all move with the green signals on one route or the other; there are no separate signals for turns.

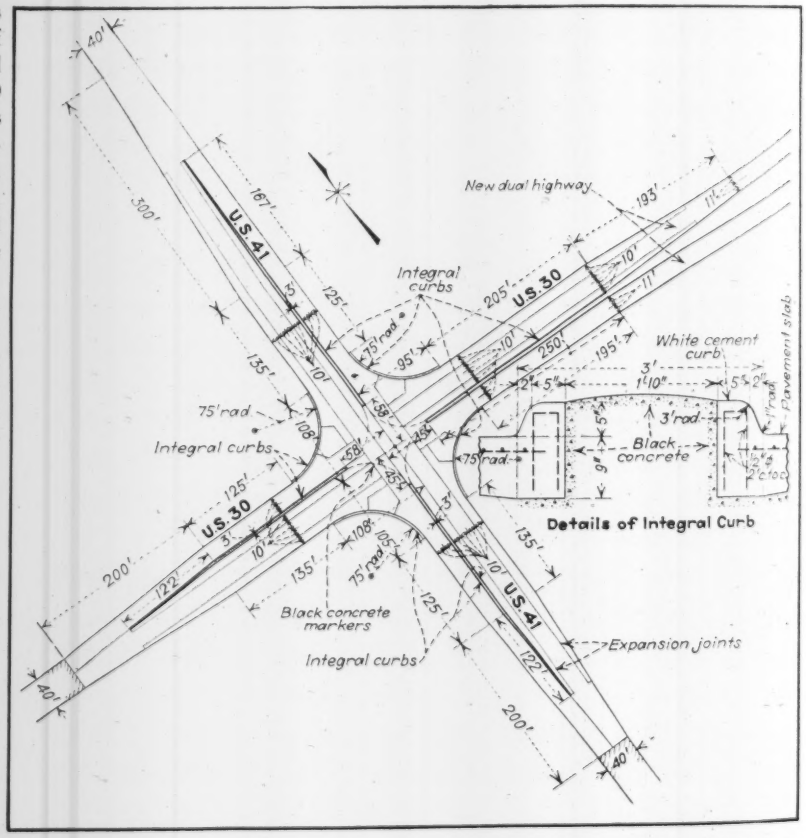

Fig. 1. Map of the unbalanced intersection. Note the locations of the offset center strips which separate opposing lines of traffic.

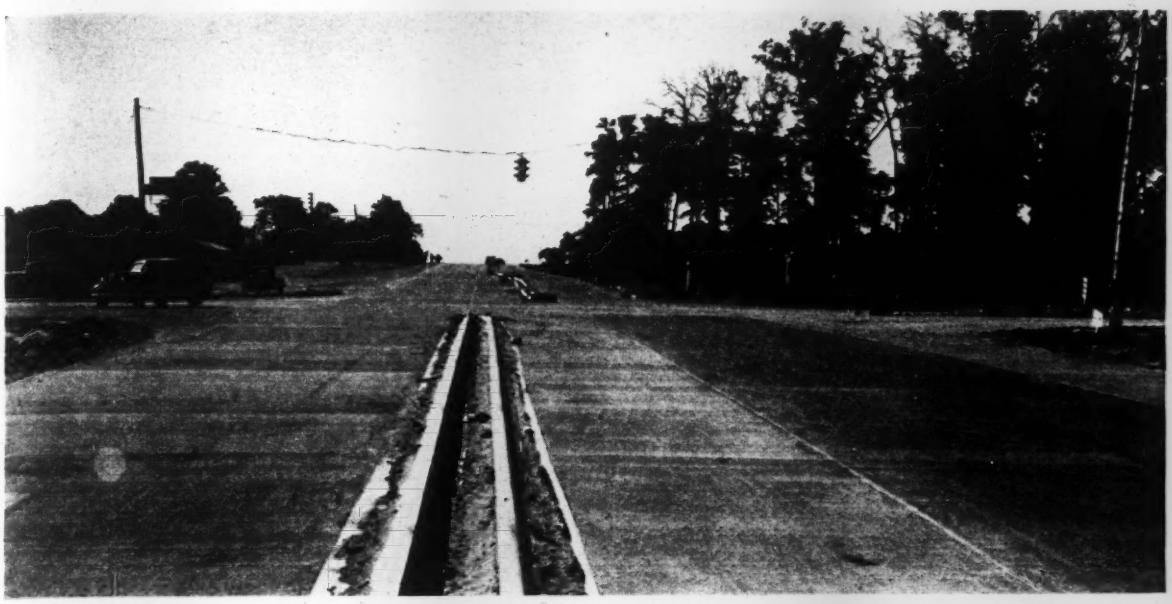

Fig. 2. Wide inlets for extra right and left turn lanes and offset center curb strips are features of a new design unbalanced road intersection in Indiana. This view is looking south on Route 41. The center overhead light has been supplemented with four corner lights, all traffic actuated. The curbs are of white-cement concrete.

A general view of the intersection is shown in Fig. 2; a map in Fig. 1. Details of design can best be given by following from the beginning of one approach through to the end of the opposite one. Starting southward at the north end of the Route 41 approach, for example, the four-lane highway starts to widen out 535 ft. from the intersection. About 135 ft. south from the point of widening the center curb strip starts. The roadway on the right side of the center curb widens out to its maximum of 40 ft. —four traffic lanes—300 ft. from the beginning of the approach; the roadway to the left of the curb remains constant at 20-ft. widths for the two exit lanes. For the next 135 ft. southward the right roadway of four lanes holds its 40-ft. width, and in this area are the traffic light control contact plates. Then the right lane swings into a 75-ft. radius curve.

The center curb strip stops just short of the west-bound roadway at the intersection. Through southbound traffic, after crossing the intersection, enters a two-lane 20-ft. roadway with a center curb on the left. These lanes are a direct continuation of the same lanes to the north of the crossing, but the center curb is offset 10 ft. to the west of the line of the similar curb in the north approach. About 400 ft. south from the intersection the exit approach merges into the old 40-ft. pavement. This same general design, except for some variation in length, applies to the east-west Route 30 roadway, except that to the east are two 22-ft. dual lanes that come together to form the same scheme of approach design.

Integral curbs of white cement concrete 5 in. high are built along the center strips and around the corners of the right turns. These curbs are built on top of the paving slab, anchored by hairpin dowels cast into the slab. The center strip curbs are 3 ft. apart; the space between is filled with black concrete struck flush with top of curbs. Reflector buttons in the curbs make them stand out at night.

As an aid to keep left turning traffic to the right of the center curb heads, black concrete blocks 12x6 in. are sunk 3 in. into the slab, flush with the top of pavement, to serve as curved guide lines between curbs of intersecting lanes. Even if a car should cut too far to the left in making the turn it could cross the center strip without trouble, as the curb faces are battered and the corners rounded.

Both design and construction of the intersection were handled by the La Porte district office under the direction of Oliver Downs, district engineer, B. E. Phelps, construction engineer, and C. A. Sweeney and H. Bowen, project engineers. Designs were approved by the highway department, of which M. R. Keefe is chief engineer. It was built by the Bontrager Construction Co., of Elkhart, Ind., as part of this firm's contract for the west end of the dual highway. C. Moore was superintendent for the contractor. The intersection required 12,450 sq.yd. of new pavement, of which 6,000 sq.yd. was made of high early strength cement to minimize the interference with traffic. The special integral curb aggregated 2,696 ft. in length. Expansion joints totaled 2,960 ft.

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Los Angeles to Build Third Power Line

SECRETARY of the Interior Ickes on July 7 approved a contract with the city of Los Angeles by which the city agrees to construct a third transmission line to Boulder Dam. After the completion of the line, the city agrees to buy secondary energy at one-half mill per kilowatt hour in annual amounts increasing from 385,000,000 kw.-hr. in 1940 to 700,000,000 kw.-hr. in 1943. The contract also sets up a formula for future readjustment of the cost of secondary power. This provides that the price of secondary energy be calculated on the basis of the price of firm energy minus the cost of standby plants and other equipment necessary to render the secondary energy as valuable as firm energy.

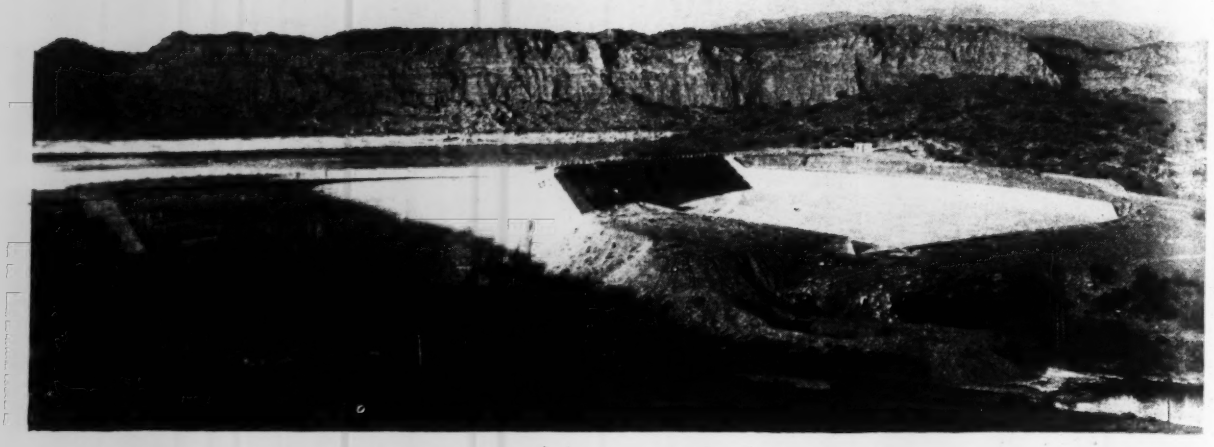

FIG. 1. NEW DISCHARGE CHANNEL GIVES STEWART MOUNTAIN DAM A UNIQUE APPEARANCE

Bigger Spillways for Salt River Dams

Program of enlargement, guided by laboratory model studies that indicated spillways would not pass their designed capacities, produced four interesting and spectacular construction jobs

CONSTRUCTION OPERATIONS of unusual character have been required in the remodeling of the four irrigation storage and power dams of the Salt River Valley Water Users Association above Phoenix, Ariz. Based on the results of operating experience and laboratory model studies, which showed that the dam spillways provided an actual discharge of only about two-thirds of their designed capacities, a program of remodeling was begun in 1936, which has only recently been completed. Included in the work was the installation of new gates and new operating machinery, lowering of spillway crests, realignment and reinforcement of gate piers, driving a 30-ft. dia. tunnel 450 ft. long, building one complete new spillway and constructing spillway aprons hung on the cliffs 200 ft. and more above the river.

The dam development of the Salt River is diagrammed in Fig. 2. The irrigation development which it serves was authorized in 1903, and Roosevelt Dam, providing the principal storage, was completed by the Bureau of Reclamation in 1911, along with a diversion dam at Granite Reef about 50 miles downstream. In 1923 a program to develop the power resources of the river was begun by the Salt River Valley Water Users Association, and Horse Mesa, Mormon Flat, and Stewart Mountain Dams were built between that date and 1930.

Operation of the complete system did not prove entirely satisfactory, particularly from the standpoint of passing water through the several reservoirs in sufficient quantity. Laboratory model studies, a design aid not available when the dams were built, revealed that the spillways were not capable of passing their design capacities of 150,000 sec.-ft. at each dam and that they should be remodeled to provide this capacity. The program of modernization, therefore, was undertaken by the Bureau of Reclamation, acting as engineer and construction supervisor for the irrigation association. Although not a part of the work described in this article, the construction of Bartlett Dam (*ENR July 7, 1938*) to provide supplementary storage on the Verde River, a tributary that enters the Salt River between Stewart Mountain and Granite Reef Dams, is a part of this program of improvement. The present completion of the spillway work will make it possible to utilize efficiently the water stored behind Roosevelt Dam and in the other reservoirs, while the completion of Bartlett Dam in 1939 will permit a greater storage reserve in the Roosevelt reservoir since Bartlett water, being flood storage which must be emptied after each flood season, will be used first.

Roosevelt Dam work

The remodeling work at Roosevelt Dam consisted in lowering the spillway crests about 6 ft. to offset a decrease in capacity caused by gate piers set at an angle to the approach channel and built by the association some years after the dam was put in service. It also included strengthen-

ing these piers with a shell of reinforcing steel and air-applied concrete and reconditioning the 19 radial gates to fit the new openings.

One of the most important improvements was the installation of a new individual hoisting motor and hoisting mechanism on each gate to take the place of a single long drive shaft. These motors receive power from two gasoline-engine-driven direct-current generators, such an independent power supply being deemed advisable since system power failure during severe floods is always a possibility.

To facilitate lowering the crest and reinforcing the piers, the radial gates were first removed and laid down on the upstream side. Then, no blasting being allowed on account of possible damage to the dam, a method of concrete removal was worked out which consisted in excavating a trench alongside each pier with concrete breakers, drilling a line of horizontal holes along the crest, and wedging the entire block between piers loose in one piece. This procedure proved to be both rapid and economical.

To aid the work of chipping, placing reinforcing steel, concreting, etc., a pipe scaffolding, put together with clamps, was used. This type of scaffold could be easily and quickly dismantled, moved and erected by a small crew, which was a distinct advantage. The contractor was Dan Peters & Co., Ogden, Utah, and the work cost $130,000. Fig 3 shows the completed spillways on Roosevelt Dam.

Spectacular job at Horse Mesa

Horse Mesa Dam, the highest of the four dams and the site of the largest power plant on the system, is located in a narrow gorge flanked by vertical and sometimes overhanging cliffs rising almost 3,000 ft. to the plateau or mesa for which the dam is named. In such a setting the reconstruction work took on a spectacular character, and particularly so since the work was done with a practically full reservoir and included the driving of a 30-ft. diameter bypass tunnel through the north abutment and the building, on the face of the cliffs over 200 ft. above the river, of spillway aprons of such length and shape that the water would be thrown clear and not flow down the abutment walls or strike the power plant directly below. Other work consisted in reconditioning the 9 radial gates and reinforcing the piers and rounding their noses. Individual hoisting motors and new hoisting mechanisms were installed on each gate as at Roosevelt Dam. To the complications of the work was added difficulty of access to the site over a steep and tortuous road, droping 2000 ft. in a distance of 6 mi., and the lack of space for a camp for 250 men, which finally was built on piles along the river bank.

The 30-ft. diameter bypass tunnel is unusual in several respects. Starting with a horseshoe section, 56 ft. high and 40 ft. wide at the upper end, the first 150 ft. of its length is transition to a circular section, in which length the invert drops 102 ft. in a parabolic curve. The first 75 ft. of the circular section then follows a circular curve in an inclined plane and drops another 42 ft., while the lower 225 ft. of the tunnel is straight and on a 3 per cent grade.

Excavation at the lower end was carried forward by the heading and bench method in 8- to 12-ft. rounds. Columns and bars were used for mounting the drills on the upper face, and a drill carriage was mounted on a crawler tractor for drilling the lower face. After a point was reached about half way up the "elbow," a pilot tunnel was driven up the raise on invert grade to intersect an upstream heading. Excavation then was completed from the upstream heading, the muck being

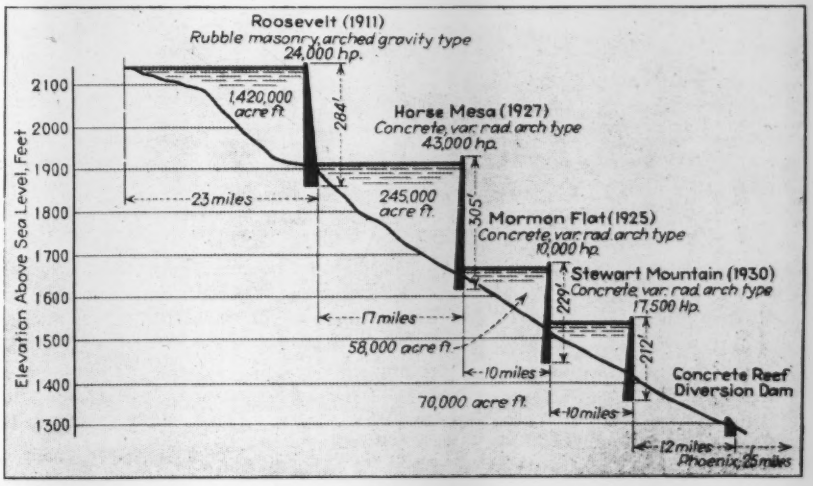

Fig. 2. Location, size and date of completion of the four Salt River Dams whose spillway capacities have been increased.

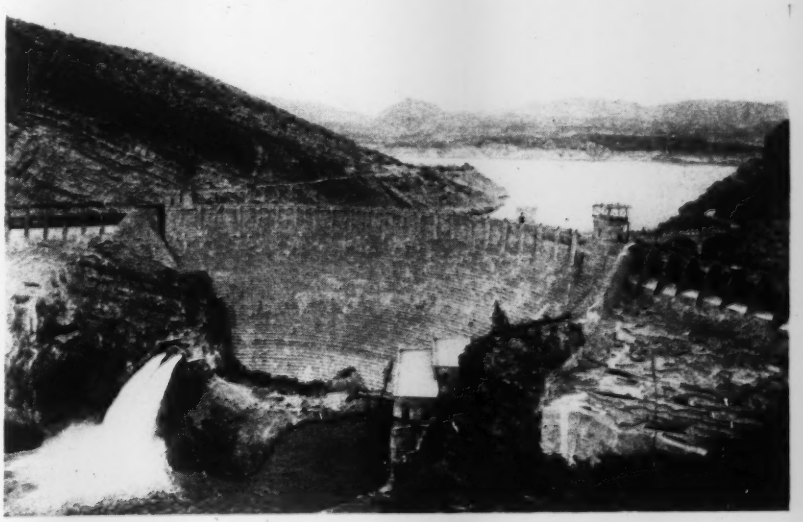

Fig. 3. Roosevelt, patriarch of reclamation dams, has had its spillway crests lowered and its radial gates reset and equipped with individual motor drives.

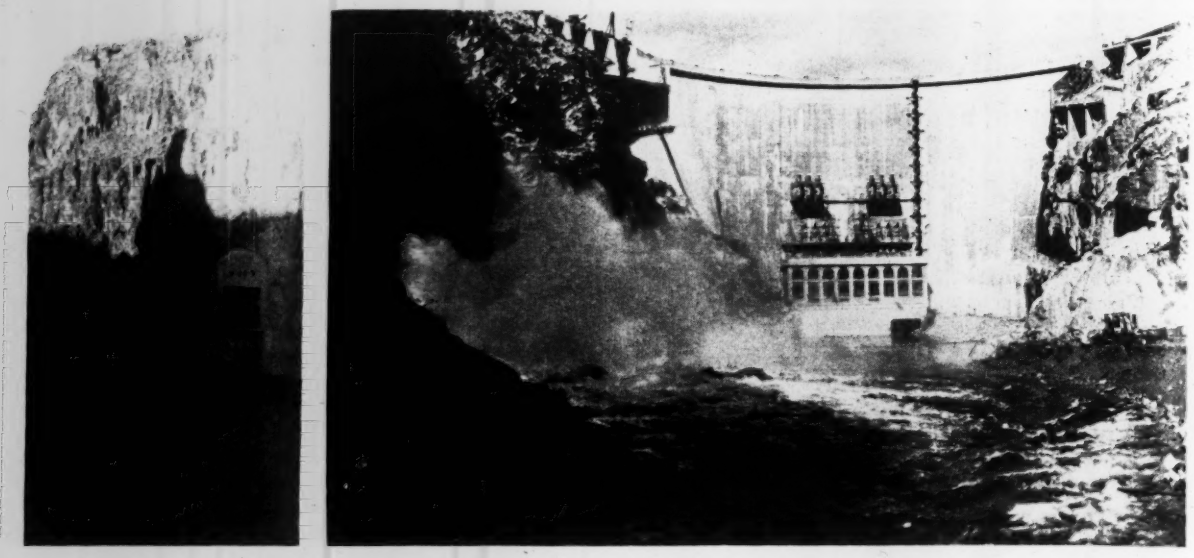

Fig. 4. Horse Mesa Dam where dangerous and spectacular work has provided a bypass tunnel and new spillway aprons supported on the face of 200-ft. cliffs. Upstream view at left shows tunnel gate structure 160 ft. high.

dropped down the pilot tunnel and removed from the lower end. Good rock was encountered and no timbering was required. The tunnel was lined with concrete.

The excavation at the upstream end of the tunnel for a gate superstructure, 60 ft. wide by 160 ft. high, was carved into the face of an overhanging cliff rising nearly 450 ft. above the reservoir. Material was handled by a power shovel and three trucks ferried to the site on a barge and operated along a made-road extending for about ¼ mi. up the reservoir. This dangerous and difficult excavation work required very careful use of explosives. As soon as it was completed a concrete arch cofferdam was built across the approach channel to allow immediate storage of water in the reservoir, whose level had temporarily been lowered. All work of placing concrete and of installing the 130-ton 40x 44.5-ft. fixed wheel gate and operating machinery was done behind this cofferdam, which had a radius of 30 ft., was 12 in. thick and 57 ft. high. The cofferdam was built in 4-ft. lifts, and each lift was divided by a metal joint into two segments, the size of the segments being controlled by the equipment available for removing them; lifting cables were attached to each piece during construction to facilitate its later removal under water.

As an aid in the construction of this tunnel a highline was built across the right spillway deck and in front of the gate house, the 50-ft. overhang of the cliff being so great that it could not pass over the gate house. All materials, therefore, were trucked across the dam, transferred with the highline to a barge, and by this moved against the cofferdam and unloaded with the highline. Another hoist was then used to drift the materials under the cliff to final position. Most of the concrete for the gate structure and for the upper portion of the tunnel was moved from the right spillway with a single-acting 8-in. concrete pump.

The remodeling of the spillways was more spectacular if not so difficult as the tunnel construction. The work, which the laboratory model studies indicated was necessary, included the rounding of the pier noses and the construction of new ogee aprons which had to be supported by pier walls, in some places as much as 40 ft. high, anchored to the faces of the canyon. An ever-present hazard in excavating for the spillway aprons was the powerhouse, with all the transmission line switching on its roof, located at the base of the dam. To safeguard this equipment it was necessary to do a large part of the blasting under mats, using small quantities of explosives. The muck was dropped into the canyon and hauled away at the lower level.

As reconstructed, the spillways will be able to carry 100,000 sec.-ft.; although originally designed to discharge 150,000 sec.-ft. they had never been able to pass more than 90,000 sec. ft. because of their position with respect to the approach channels. The 50,000 sec.-ft. capacity of the new tunnel will bring the total discharge up to the originally contemplated value. In addition, when the reservoir level is below the elevation of the spillway crests, it will be possible to bypass irrigation water through the new tunnel instead of passing it through the turbines in the power house, a practice which not only wasted generated power but did not feed the water to the reservoirs below at a rapid enough rate to supply the irrigation demand. The tunnel will also be available for discharge during times of flood.

Contract for the Horse Mesa Dam work was carried out by L. E. Dixon Co., Bent Bros. Inc., and Case Construction Co., Inc., Alhambra, Calif., at a cost of $1,000,000.

New spillway at Mormon Flat

The job at Mormon Flat Dam consisted in removing entirely the old spillway and nine radial gates. The layout of this old spillway was such that the gate piers were set athwart the approaching stream, which caused a pile-up of water against the upper sides, thus cutting down the discharge to about 60 per cent of its design figure. For this old spillway there has been substituted a curved and superelevated channel around the left abutment, controlled by two 50x50-ft. regulating gates set directly across the line of flow, and

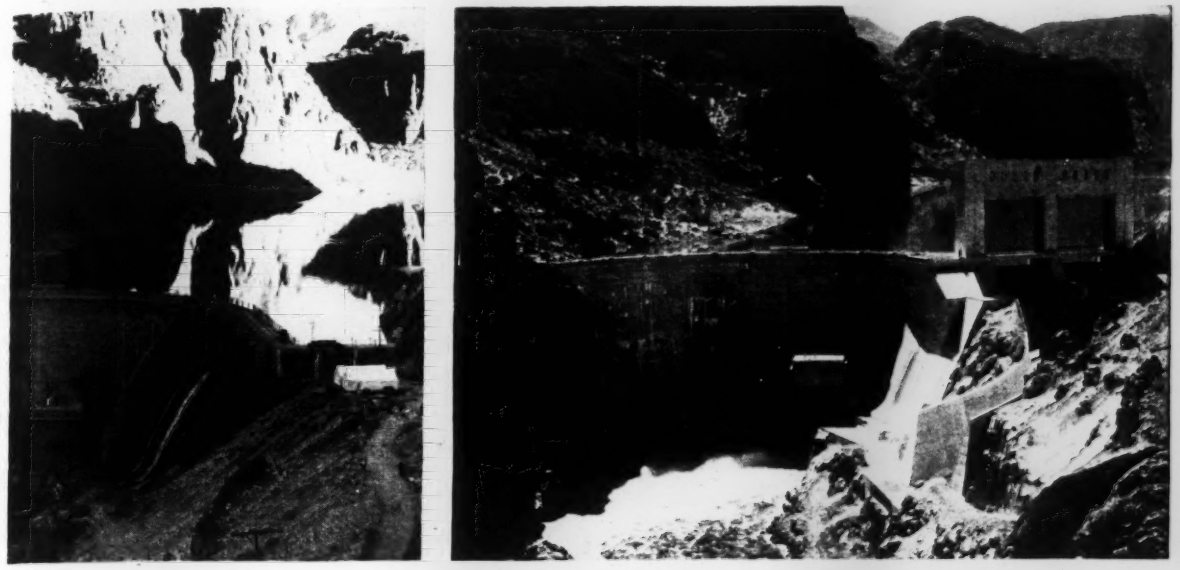

Fig. 5. Old and new spillways at Mormon Flat Dam. Note how buttress effect of old spillway is replaced in the new work by a heavy concrete thrust block.

normal to the axis of the old spillway. The new concrete-lined channel is 450 ft. long and 50 ft. deep and tapers from a 100-ft. width at the gates to 45 ft. at the discharge end. Its drop is 53 ft.

The first job on the program was cutting up the old radial gates with acetylene torches. Then, to break up the concrete, a 6000-lb. iron ball was hung from a guy derrick boom and repeatedly lifted and dropped. Excavation for the channel was mostly rock, and careful use of explosives was necessary so as not to injure the left abutment of the dam. The greater part of this excavated material was hauled upstream and dumped into the reservoir.

Removal of the old spillway also removed some of the support for the left side of the dam at the point where the main arch section joined a gravity abutment section. A heavily reinforced concrete thrust block was therefore built at this point, its purpose being to maintain the stability of the dam as a whole and also to anchor the arch more securely to the concrete gravity section. Attaching this thrust block to the dam was accomplished by drilling about 250 holes through the end of the arch dam in which were grouted 1¼-in. sq. bars of high strength reinforcing steel. A heavy anchor plate was welded to the upstream end of each bar and the downstream end was embedded in the concrete of the thrust block.

The work on Mormon Flat Dam was done by Gunther & Shirley Co. and J. P. Shirley of Los Angeles at a cost of $850,000.

Wide apron at Stewart Mountain

At Stewart Mountain Dam, in addition to reconditioning the 9 radial gates and installing new individual motors and hoisting mechanisms as well as two gasoline-engine-driven direct-current generators, a discharge channel 450 ft. long and 265 ft. wide was excavated and lined with concrete below the spillway.

Excavation from the spillway channel, consisting mostly of cemented gravel and caliche, was disposed of at the downstream side of the left abutment of the dam and the upstream side of the gravity section to the left of the spillway, thus giving the entire structure the appearance of greater strength and stability.

Immediately downstream from the gates, the channel lining is a supported floor for a distance of about 75 ft., bridging a deep hole which had been washed out by water passing over the spillway. Elsewhere the channel is a paved slab resting on the ground. The channel is on a curve and is superelevated, while a portion of the right wall has a seawall coping to prevent water from splashing over. The contractor was the Allied Bridge & Construction Co. and the Central Bridge & Construction Co., Omaha, Neb. The cost of the work was $350,000.

The Salt River dam spillway designs were prepared in the Denver office of the Bureau of Reclamation. John C. Page is commissioner. R. F. Walter, chief engineer and J. L. Savage, chief designing engineer. E. C. Koppen, construction engineer, is in general charge of the Salt River work. J. A. Fraps was resident engineer until August, 1937, and Allen Mattison thereafter.

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Ten Miles of Welding on Grand Coulee Penstocks

THE FIRST SHIPMENT of 9,000 tons of steel plate for the penstocks at Grand Coulee Dam arrived on the job July 8, according to the *Columbian*, publication of the Consolidated Builders, Inc., contractor on the dam. Fabrication of the plate into 6-ft. and 18-ft. steel pipes to be encased in the dam was started at once by the Western Pipe & Steel Co.

Fabrication will be entirely by welding, and the length of all welds is estimated at ten miles. Every inch of the welding will be inspected by X-ray. There are three 6-ft. penstocks 322 ft. long to feed the service generators. Each of the 18-ft. main generator penstocks, (9 on each side of the river), is 293 ft. long. For these pipes four semi-circular plates 10 ft. long are being automatically welded into complete sections 20-ft. long.

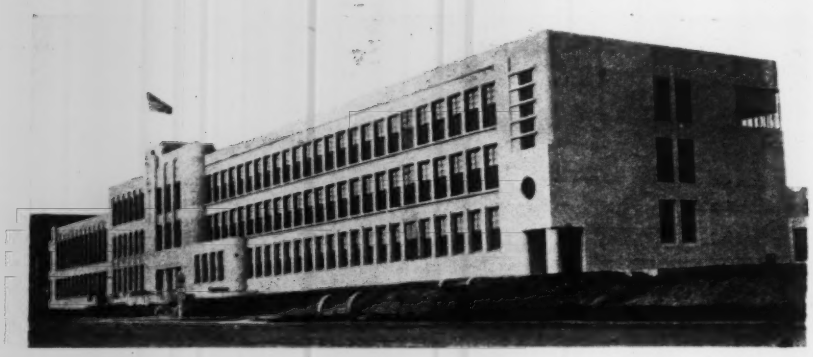

FIG. 1. DUMMY JOINTS ARE USED IN THE FACADE OF THIS BELLINGHAM SCHOOL.

Crack Control in Concrete Walls

A. M. YOUNG
Seattle, Wash.

The principle of the dummy joint in concrete pavement, applied to a building wall, preserves neat appearance of Bellingham school exterior

A NEW HIGH SCHOOL for 1,800 pupils at Bellingham, Wash., has a main facade 354 ft. long whose architectural appearance would be marred seriously by random and irregular shrinkage cracks. To avoid danger of any such disfigurement the principle of the dummy joint as used in concrete paving practice was applied to the concrete walls of the building exterior. The experiment has been observed carefully to make sure that the expected result was actually attained and now, nearly a year after the job was completed, it can be stated definitely that the joints have functioned most successfully.

The school building consists almost entirely of reinforced concrete: the exterior was given an architectural treatment in which emphasis was placed on the horizontal courses presented by the deep spandrel sections. Although additional reinforcement might have prevented the occurrence of cracks, the writer's experience indicated that it might not, and the suggestion that dummy joints be used was regarded favorably.

The walls and spandrels in general are 9 in. thick, reinforced on both faces; horizontal bars are ⅜-in. rounds, 8 in. on centers; vertical bars, of the same size, are spaced 12 in. apart. The outer reinforcement curtain is 2 in. in from the face of the wall.

Dummy joints were placed in vertical planes extending from a point 1 ft. below grade to the top of the parapet. They consist of straight, vertical grooves about ¼ in. wide; 1½ in. deep on the exterior face of the wall and 1 in. deep on the inner face. The outer grooves were formed with metal strips one of which, resembling a water stop in a dam, is left in at the bottom of the groove. Grooves on the inner face were formed by wood strips left permanently imbedded in the concrete. After the reinforcement had been placed, every alternate horizontal bar passing through the dummy joint was cut to weaken the reinforcement in this section.

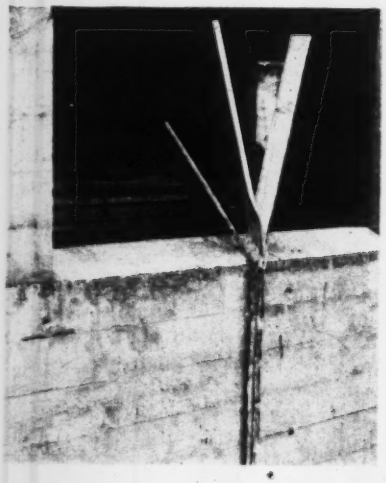

Fig. 2. Metal strips at a window opening forming exterior dummy joints.

Thus at uniform intervals along the wall, planes of weakness were created in which the cross section of concrete and steel was only about two-thirds that prevailing elsewhere in the wall. Just prior to the application of the color coat on the building exterior, the grooves were filled with a mastic. The inner face of the wall was furred 2 in. for plastering. In interior corridor walls of the one-story portion of the building similar dummy joints were centered over door openings.

The outer grooves in the exterior walls were formed by making a continuous vertical cut ¼ in. wide in the form boards and inserting through this cut folded metal strips which extended 1½ in. beyond the inner face of the form. Strips of different shapes were tried with progressive improvement in results. In Fig. 2 the two larger metal strips were subsequently removed leaving space for the mastic filling the outer portion of the groove. The smaller metal strip was left in place.

Subsequent to completion of this job the writer has seen a still further improvement being used at Montebello, Calif., consisting of a strip of light-gage metal in T-form which is filled and held in shape by a beveled strip of wood. When the metal has fulfilled its function removal of the wood filler strip permits the collapse and easy withdrawal of the metal.

Careful inspection of the concrete after nearly a year of service shows that at window heads, in the wall section beyond the groove depth, fine cracks can be seen extending straight back from the base of the outer grooves to meet the grooves on the inside. No cracks have appeared elsewhere in the walls provided with the dummy joints. The joints themselves are not conspicuous and are devoid of architectural significance. Where continuous bands of flutes occur, as at the parapet line of the main facade and along certain one-story portions of the building, the joints are concealed entirely.

In the interior corridor walls the single dummy joint centered over the door openings worked satisfactorily. But in two or three door openings a vertical crack formed at the corner of the opening not more than two feet away from the dummy joint. As

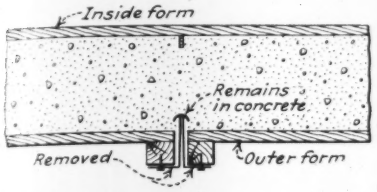

Fig. 3. Plan of wall shown in Fig. 2, indicating relationship of the metal strips.

a result of this indication, in future the writer would use a pair of dummy joints at such doorways, one to be located at each corner of the opening.

Floyd A. Naramore, Seattle, was architect on the building for which the writer prepared the structural design. Hendrickson-Alstrom Co. were the general contractors.

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Roughing it in Paraguay

PROOF that old-timers still can take it was given by Fred Lavis, consulting engineer, in reporting recent experiences in Argentina and Paraguay in a talk before the American Institute of Consulting Engineers. Examining a project for an international highway, projected to run for a distance of some 250 miles easterly from Asuncion, involved experiences reminiscent of the explorations of old-time railway locating engineers.

"The first part of the trip was made over existing dirt roads by automobile and even that was fairly rough. It was made, however, through inhabited country with small towns where food and sleeping accommodations were available. The second part of the trip was made partly by truck, in mule wagons or ox carts, on saddle animals and by motor boat; the motor, however, worked only spasmodically. On the last part of the trip the speaker, with one engineer assistant, took six days to travel about 35 or 40 miles through the dense forests where a path had to be hacked by machetes for most of the distance. On this part of the trip, because of the fact that only one pack animal was available, and because it took much longer than was expected, provisions gave out and the only food was some cheese and rough corn pone that the guide had brought along."

Photoelastic Analysis Broadened

ELMER K. TIMBY and IRA G. HEDRICK, JR.,
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Designer, Waddell & Hardesty, New York, N. Y.

Three-dimensional stress problems yield to a procedure utilizing laminated models with a polarizer layer

THE PHOTOELASTIC method of stress determination in models has usually been restricted to the special problems in which only two-dimensional stress exists throughout the thickness of a body, that is, at every point along a straight line passing completely through the body, two of the principal stresses are each perpendicular to the line and invariant in magnitude and direction, while the third principal stress is equal to zero. Unfortunately, and far too frequently, necessity rather than preference has dictated the assumption of two-dimensional stress throughout the thickness of a model when in fact it was three-dimensional. However, since two-dimensional stress does exist at the unloaded surface of every body regardless of the variation throughout the thickness, and since these surface stresses are greater than any stresses within the body, photoelasticity can be used to obtain the critical stresses in the usual problem if it is applied to the surface layer. This article describes how, by the use of Polaroid, a thin material which polarizes light by simple transmission, it is possible and practicable to find the surface stresses in a structure subjected to three-dimensional stress and strain.

The photoelastic method for finding the algebraic difference between (and the directions of) the two principal stresses in a structure having a two-dimensional stress system has been developed extensively. Also many well known supplementary methods, as outlined in 1, 2, 3, and 4 of the accompanying bibliography, have been devised for finding the algebraic sum of the principal stresses. Therefore, if p is one principal stress and q the other, and C_1 and C_2 are constants which can be evaluated by the photoelastic and a supplementary method, respectively, the two simultaneous equations,

$p - q = C_1$ (from photo-elasticity)
$p + q = C_2$ (from a supplementary method)

are sufficient to evaluate the two principal stresses, thus giving a complete solution for a two-dimensional stress problem.

Mesnager[5] suggested in 1930 a possible method by which surface stresses could be evaluated, namely by using a thin doubly-refractive layer applied to a reflecting surface on the structure being investigated. Favre[6] in the same year used a model of two materials—an optically sensitive glass imbedded within a mass of Pockels glass, which does not become doubly-refractive when stressed. This allowed the determination of stresses at a point within a body. The practical difficulties of these methods of analysis are emphasized by the scarcity of solutions. It is believed that the following procedure, involving the use of Polaroid is both possible and practical.

Necessary assumptions

At the unloaded boundary of any stressed body, one of the three principal stresses is equal to zero and perpendicular to the boundary while the

Bibliography

1. "Photo-Elasticity", Coker and Filon, p. 178—Use of lateral extensometer.

2. "Photo-Elasticity," Coker and Filon, p. 410—Explanation of Filon's graphical integration.

3. "Zeitschr. angew. Math. u. Mech.," J. P. den Hartog, 1931, p. 156—Use of membrane analogy.

4. "Exact Construction of the (f_1-f_2) Network from Photoelastic Observations," by Heinz P. Neuber, presented at the annual meeting of the A.S.M.E., December, 1933.

5. "Sur la determination optique des tensions interieures des solides a trois dimensions," by A. Mesnager, Comptes Rendus, Institut de France, Academie des Sciences, Vol. 190, 1930, p. 1249.

6. "Sur une methode optique de determination des tensions interieures dans les solides a trois dimensions," by Henry Favre, Comptes Rendus, Institut de France, Academie des Sciences, Vol. 190, 1930, p. 1182.

Further, on a surface parallel to the boundary surface, and at an infinitesimal distance within the body, the shear stress is equal to zero. By making the assumption that the boundary condition exists for a small finite distance within the body, the surface stresses can be evaluated by the method to be described.

As in the common two-dimensional photoelastic analysis, the data to be obtained are (a) the algebraic difference between the principal stresses at a point, and (b) the directions of these principal stresses. The sum of the principal stresses at the point can be obtained by some supplementary method, thus completing the analysis of the problem.

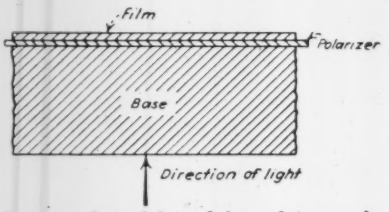
Proposed method

In the proposed method of analysis for three-dimensional stress problems, the skin of the model is used as the stressed photoelastic medium. The light enters the body of the model as ordinary light and is polarized just before it leaves the inner skin layer. Therefore, the fringe pattern formed on the screen is the result of relative retardation produced by the stresses in the outer skin layer or film.

The model for this method of analysis is laminated. It is not necessary that the model be of constant thickness, nor need it have plane surfaces, although in the accompanying illustration it is so shown schematically for simplicity. When of variable thickness the model should be immersed in a liquid, the refractive index of which is equal to that of the film and base. This liquid will prevent divergence of the light beam, which should be kept reasonably parallel as it passes through the model.

The base may be any transparent material having desirable elastic properties, particularly a Poisson's ratio that is the same as in the prototype. The permanent double refraction or the stress-optic coefficient of the material in the base has no significance; it is only necessary that the light remain parallel while passing through it.

The polarizer is Polaroid a material which has recently been made commercially available. Consisting of a fixed suspension of uniformly oriented polarizing crystals in a cellulose acetate sheet approximately 0.004 in. thick, it polarizes light by



Laminated model used for solving problems in three-dimensional stress by the photo-elastic method.

simple transmission uniformly over its area. Furthermore it is not affected by ordinary temperatures used in annealing or cementing. Although it is generally available only in laminated form between glass plates, for the purpose of this study laminations were made available by special arrangement on loan.

The film is the photoelastic material in which the stresses are determined. Therefore, since of necessity the film must be thin it is desirable that it be composed of a material having a high stress-optic coefficient (relative retardation produced by unit stress per unit of thickness). Several such materials — bakelite, marbelette, or celluloid—are available. Finally the base, polarizer, and transparent film must be cemented together to form one integral piece, making it desirable that the three materials have similar elastic properties.

Since Polaroid produces plane polarized light the pattern produced by the film under stress will contain an isoclinic as well as isochromatics. This isoclinic (a locus of points at which the principal stresses have the same directions) gives the direction of some of the principal stresses, and the isochromatics (an isochromatic is a locus of points at which the algebraic difference between the principal stresses is the same) give the algebraic differences between the other principal stresses. Since the polarizer and analyzer cannot be rotated with respect to the model, it is necessary to determine, by some method other than the one usually employed, the directions of principal stresses not located in the visible isoclinic. Furthermore the assumption that the boundary condition is constant throughout the thickness of the film is more nearly realized if the film is thin. However, since a thin film tends to produce widely spaced isochromatics, it is necessary to use a precise method to determine the relative retardation in the film.

A calibrated crystal plate, such as a Soleil-Babinet compensator, may be used to serve the double purpose of measuring the relative retardation and also of determining the direction of the principal stresses at a point. This compensator ("Photo-Elasticity for Engineers," Filon, p. 43) is equivalent to a crystal plate of uniform thickness, and its construction permits this thickness to be changed by means of micrometer adjustment.

In using this compensator consider a short portion of a line orthogonal to the isochromatics and extending between two of them. Estimate visually the approximate relative retardation at a point along this line and near which the exact relative retardation and directions of principal stresses are desired. Adjust the compensator to this approximate relative retardation and place it in the ray of parallel light which has passed through the selected point on the model. In general, the axes of the compensator will make some angle with the directions of the principal stresses in the model. Now rotate the compensator about the axis of propogation of the light until extinction is observed on the line in the vicinity of the selected point. At this point of extinction the unknown relative retardation caused by the stresses is equal and opposite to the known relative retardation produced by the compensator, and the directions of the principal stresses are parallel to the axes of the compensator. The directions of the axes of the compensator are known and, therefore, the parameter of the isoclinic which passes through the point is known. By repeating this procedure at a sufficient number of points the isochromatics and isoclinics may be determined for an entire area, thus completing the photoelastic information.

If it is desirable to know the differences between the principal stresses at all points the isoclinic may be eliminated from the field by using a second model with the polarizer differently oriented, or by using circularly polarized light. Circularly polarized light may be obtained by cementing a quarter-wave plate of some material whose retardation will not be affected appreciably by the stress between the Polaroid and the film. The operations described above for finding the difference between, and the directions of, the principal stresses at a point apply also in the

case of circularly polarized light.

The value of each isochromatic in pounds per square inch may be determined by calibrating a film similar to that used on the model. This may be done conveniently by means of either a beam under constant moment or a uniformly stressed bar.

The above described procedure could be accomplished with a tension compensator or with a set of accurately calibrated fractional wave plates instead of the Soleil-Babinet compensator. Fractional wave plates may be made for this purpose from mica, cellophane or other synthetic cellulose sheets, and calibrated with a Babinet compensator.

By making use of the assumption that the shear stress on the interior surface of the film is zero, the solution for the individual stresses may be completed by use of some supplementary method of obtaining the algebraic sum of the principal stresses in the same manner as would be employed for two-dimensional stress.

The authors wish to acknowledge the assistance of The Polaroid Corp., Boston, Mass., in solving cementing problems which have arisen and in loaning materials which have not been generally available. The work incident to the development of the method herein described was done at Princeton University.

A Picture of Pollution In the Hudson

C. J. VELZ

Senior Engineer, PWA Region I, New York

The degradation of one of America's great rivers can be halted only by the installation of treatment works throughout the entire drainage basin

Since his extensive river pollution studies of 1932 with Prof. Earle B. Phelps of Columbia University, the author, as acting chief engineer of PWA in New Jersey and recently senior engineer, Region 1, PWA, has had close contact with pollution abatement problems in the New York metropolitan area. In the following article he outlines conditions as they are today and indicates what remedial measures must be undertaken.
—EDITOR.

OVER 10 million people, one-seventh of the nation's urban population, utilize the Hudson River and its tributaries for the ultimate disposal of their wastes. Throughout the years pollution has steadily increased and with but few of the larger cities and industries providing treatment before discharge, the Hudson has been degraded to the point where sections are grossly polluted. Recent river surveys reveal an increasing bacterial content along with critical depletions of dissolved oxygen. Engineering studies clearly show that only by concerted action in providing treatment facilities can the Hudson be restored to a condition consistent with future use.

The total daily volume of untreated wastes discharged into the drainage area (of some 14,400 sq. mi.) has been estimated to exceed 1⅓ billion gallons, a flow equivalent to about one-half of the dry weather runoff. Three-fourths of this tremendous pollutional load is contributed by the New York metropolitan district in the lower 50 miles of the river. The distribution of the pollutional load, commencing at the head waters and proceeding to the mouth, is indicated in Table I, which shows the cities served by sewers, and the treatment provided. Data concerning industrial pollution are meager. It is known, however, that heavy loads are contributed in the vicinities of the junction of the Mohawk and Hudson, and in the New York metropolitan area, particularly along Newark Bay and the Kills.

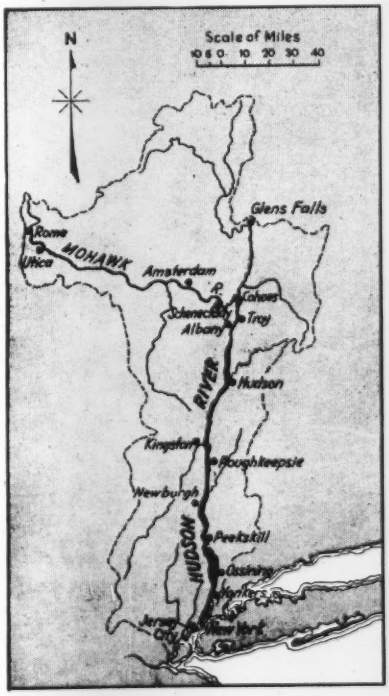


Fig. 1. Drainage area of the Hudson River and its tributaries

Facts about the river

The Hudson, for 160 miles up to the Troy Dam, is a deep tidal channel. The only large tributary is the Mohawk with a watershed of 3,500 sq.mi. which joins the river above the Troy Dam. The runoff below Albany is controlled largely by the impounding dam at Troy, with the critical flows occurring in the month of August. The August mean runoff is 0.45 c.f.s. per sq.mi. with a distribution ranging from 0.2 to 1.8 c.f.s. Large flows of seawater enter at the Narrows and intrude up the Hudson 40 to 50 miles (depending upon the land water runoff) with concentration of 10 per cent seawater at the end of Tappan Zee during mean August flow.

Although there is no one absolute index, the most inclusive and best single measure of degree of pollution

Fig. 2. New York Harbor into which the Hudson empties

and natural purification capacity of a stream is the variation in the dissolved oxygen content of the waters. From a study of pollution liabilities and stream assets the dissolved oxygen content of the Hudson River has been observed and computed at various locations for the low summer runoffs, as shown in Fig. 3A. From this the general condition of the river is apparent.

Because of the heavy concentrations of municipal and industrial wastes at the head of the tidal region the dissolved oxygen drops rapidly to 35–45 per cent of saturation below Albany. In passing through the wide shallow reaches of the river about 90 per cent of this load is satisfied and the oxygen is again rebuilt by heavy reaeration to 75 per cent of saturation near Kingston. Through the narrow deep rocky gorge sections from Kingston to Peekskill (with relatively small additional pollution) the oxygen gradually drops to 65–70 per cent of saturation until it reaches the wide and shallower areas of Tappan Zee. At this point reaeration is again effective in increasing the oxygen content to 80–85 per cent of saturation.

Critical sections

The deep gorge section from Kingston to Peekskill is not as safe as its comparatively high oxygen contents would indicate. A relatively small increase in pollution load in this region, either as residual from upstream or as a direct discharge will reduce the oxygen content substantially because of very slight reaeration capacities through the deep narrow channels.

During periods of low runoff, when brackish waters extend above the Narrows to the Zee (Fig. 2) downstream pollution of the metropolitan area is actually carried up-

TABLE I — DATA ON COMMUNITIES WITH AND WITHOUT SEWAGE TREATMENT FACILITIES IN THE HUDSON RIVER DRAINAGE BASIN

Mohawk River

Head Waters to Junction with Hudson

Location	Population 1930	Treatment
ROME	32,338	Primary 1, 3, 10
ORISKANY	1,142	Primary 2, 10
ORISKANY FALLS	853	None
WHITESBORO	3,375	None
YORKVILLE	3,406	Primary 1
CLINTON	1,475	None
NEW YORK MILLS	4,006	Primary 1
UTICA	101,740	None
FRANKFORT	4,203	Primary 2, 10
ILLION	9,890	
MOHAWK	2,835	
HERKIMER	10,446	Primary
DOGELVILLE	3,309	Primary 1
LITTLE FALLS	11,105	None
SAINT JOHNSVILLE	2,273	None
FORT PLAIN	2,725	None
NELLISTON	553	None
FULTONVILLE	831	Primary 1
CANAJOHARIE	2,519	Primary 1, 3, 10
FONDA	1,170	None
GLOVERSVILLE	23,099	Secondary 1, 5, 7, 8, 10
JOHNSTOWN	10,801	None
AMSTERDAM	34,817	None
SCHENECTADY	95,692	Secondary 2, 5,
	50,000*	9, 10
SCOTIA	7,437	None
COLONIE	1,700	Primary 1, 10
COHOES	23,226	None
	396,966	

Hudson River

Head Waters to New York City

CORINTH	2,613	Primary 1
GLENS FALLS	18,531	None
HUDSON FALLS	6,449	None
FORT EDWARD	3,850	None
SARATOGA SPRINGS	13,169	Secondary 1, 7, 10
BALLSTON SPA	4,591	Secondary 1, 6, 9, 10
HOOSICK FALLS	4,755	None
MECHANICVILLE	7,924	Primary
WATERFORD	2,921	None
WATERVLIET	16,083	None
GREEN ISLAND	4,331	None
TROY	72,763	None
ALBANY	127,000	Primary 2, 10
RENSSELAER	11,223	None
DELMAR	4,000	Primary 2, 10
	2,400*	
MENANDS	1,522	None
CASTLETON	1,506	None
RAVENA	1,963	Primary 2, 10
COXSACKIE	2,195	None
ATHENS	1,618	None
HUDSON	12,337	None
CATSKILL	5,082	None
SAUGERTIES	4,060	Primary 1
KINGSTON	28,088	None
WALDEN	4,283	Primary 1, 3, 9,
	3,400*	11
HIGHLAND FALLS	2,900	Primary
HIGHLAND	2,000	Primary 1, 3, 9, 11
POUGHKEEPSIE	40,288	None
WAPPINGERS FALLS	3,336	Primary 2, 10
BEACON	11,933	Primary 1, 3, 11
	5,000*	
NEWBURGH	31,275	None
CORNWALL	2,000	Primary
WEST POINT	3,500	None
GOSHEN	2,891	Secondary 1, 7, 10
COLD SPRINGS	1,784	None
PEEKSKILL	17,125	None
HAVERSTRAW	5,621	None
WEST HAVERSTRAW	5,621	Primary 1, 9
OSSINING	15,241	9
BRIARCLIFF MANOR	1,794	Secondary 1, 7
NORTH TARRYTOWN	7,417	9
TARRYTOWN	6,841	9
DOBBS FERRY	5,741	None
NYACK	5,392	None
SOUTH NYACK	2,242	None
PIERMONT	1,765	Primary 2, 10
	1,300*	
IRVINGTON	3,067	None
HASTINGS	7,097	None
NORTH YONKERS	81,600	9, 12
SOUTH YONKERS	231,000	9, 12
	862,253	

New York Harbor

Hudson River—East River—Upper Bay

ENGLEWOOD CLIFFS — NJ	810	Primary 2, 11
FORT LEE — NJ	7,000	None
EDGEWATER — NJ	4,089	None
CLIFFSIDE PARK — NJ	10,000	None
NORTH BERGEN — NJ	10,000	None
GUTTENBERG — NJ	6,535	None
WEST NEW YORK — NJ	37,000	None
UNION CITY — NJ	48,000	None
WEEHAWKEN — NJ	14,807	None
HOBOKEN — NJ	59,261	None
JERSEY CITY — NJ	105,000	None
NEW YORK	834,000	None
NEW YORK East River	3,949,000	Secondary 4
	1,300,000*	
NEW YORK Upper Bay	1,110,000	None
BAYONNE — NJ Upper Bay	22,500	None
PASSAIC VALLEY OUTLET Upper Bay	1,179,000	Primary 1, Sludge Barged to Sea
	7,397,000	

Newark Bay and Tributaries

HACKENSACK VALLEY	250,000	Part Treated
RAHWAY VALLEY	65,000	Primary 1, 9, 10, 11
ELIZABETH VALLEY	300,000	Primary 1, 9, Sludge Barged to Sea
ARTHUR KILL	80,000	None
NEWARK BAY	370,000	None
	1,065,000	

Lower New York Bay

NEW YORK	23,000	None
RARITAN Valley	250,000	Intermediate Treatment
	273,000	

NOTE: * Part of Population Served

KEY:

1. Plain sedimentation
2. Imhoff tank
3. Sludge digestion
4. Activated sludge
5. Trickling filters
6. Contact beds
7. Sand filters
8. Final settling tanks
9. Chlorination
10. Open sludge beds
11. Covered sludge beds
12. Fine screens

stream by the intruding seawater flows. This effect of downstream pollution combined with a heavy load from the Westchester County region is evidenced by a sharp drop in the dissolved oxygen at the upper end of the brackish waters. From here to its outlet at the Narrows the river acquires the heavy pollution of the metropolitan district which during the low summer runoff periods depletes the oxygen to 0–5 per cent of saturation in a critical region just above Upper New York Bay.

It is interesting to note that B-coli numbers, which are an index of the sanitary quality of the water, parallel the dissolved oxygen variations as shown in Fig. 3B. Bacterial contamination from the Albany area is subject to rapid reduction through the wide shallow sections to Kingston, slow reduction through the narrow deep gorge section and again accelerated reduction through the wide shallow regions of Tappan Zee.

Remedial measures

For communities above the metropolitan area an evaluation of the effect of various remedial measures upon the river condition indicates that as a first step in the restoration of the Hudson the present pollution load—municipal and industrial—should be reduced by one-third. To accomplish this the minimum treatment required is sedimentation and chlorination. With such treatment the monthly average dissolved oxygen of the Upper Hudson during summer periods should not fall below 65 per cent of saturation more often than once in 5 years. Further, the entire course of the river will be free of visible evidence of sewage, foul sludge banks at outfall sewers will be eliminated and the sanitary quality of the water will be improved.

Abatement of the gross pollution of the lower Hudson in the metropolitan area is a more complex problem. New York Harbor, for instance, is an inter-relation of branches which, by configuration and complexities of tidal flow, are integrated into a whole; pollution of one branch, therefore, affects other reaches and conversely, purification of one favorably affects others. The greatest return for the least expenditure of funds (consistent with a reasonable restoration of the lower Hudson) indicates the employment of a minimum treatment by sedimentation augmented by flexible intermediate treatment for summer periods.

During the past quarter of a century there has been much discussion of the need for pollution abatement in the Hudson Valley but many difficulties have been encountered, principally in connection with problems of interstate cooperation and financing. In the past five years some progress has been made as a result of the efforts of the New York and New Jersey state health departments and the Interstate Sanitation Commission.

For maximum return from the investment in sewage and waste treatment works it is axiomatic that the problem be approached by drainage areas as a whole. And in the interests of efficiency all communities, large and small, must assume individual responsibility for adequate treatment. In coordination with the stated objectives of the New York State Department of Health to clean up the Hudson River by 1940, and the offer of grants-in-aid of 45 per cent of the cost by the federal government through the PWA, the present time seems most opportune for action.

It is encouraging to note that a start toward pollution abatement has actually begun. New York City, for instance, is actively engaged on a program the first important project of which, the Ward's Island disposal plant, is completed and in operation. New Jersey communities likewise are active, and in this state last year were placed in operation treatment works in the Elizabeth, Rahway and Raritan valleys. Plans for treatment are well advanced for the Hackensack valley.

However, much remains to be done, as will be seen from a study of Table 1. The installation of treatment works in communities throughout the entire drainage basin is the only remedy for pollution abatement in the Hudson.

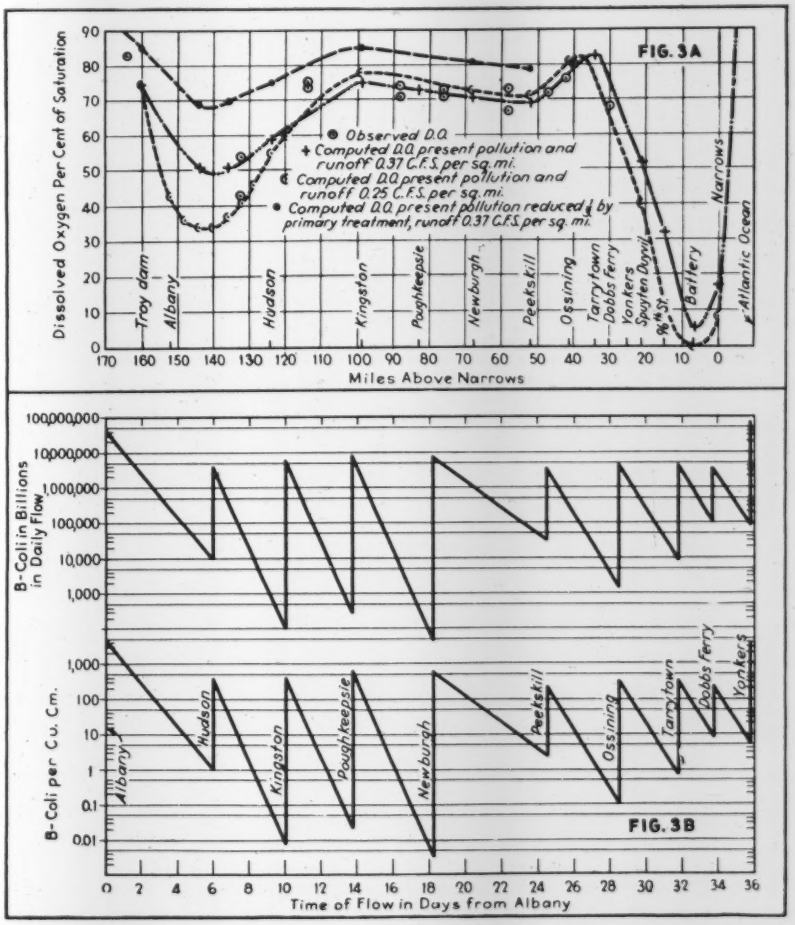


Fig. 3. Date from sanitary surveys showing (A) the dissolved oxygen profile; and (B) the contamination of the river as revealed by bacterial counts (reported by Phelps and Hall)

Dam Tested by Artificial Earthquakes

Vibrations set up by an oscillator measured as a check on computed period of vibration to forecast the effect of earthquakes on Morris Dam

A SERIES of observations on the effect of vibration on Morris Dam of the Pasadena water system has been made as part of the seismic investigation program carried on by the U. S. Coast & Geodetic Survey, cooperating (on this particular structure) with the city of Pasadena. The tests and studies were directed toward learning as much as possible about vibrations in the dam as a check on calculated values, by observing the effect of vibrations caused by a shaking machine that set up vibrations similar to those made by an earthquake. An indirect objective was to determine the limitations of the shaking machine, which essentially is a set of motor-driven eccentric flywheels. (*ENR*, Nov. 14, 1935, p. 680).

Morris Dam is a concrete structure of gravity section, maximum height 328 ft., height above streambed 245 ft., thickness at lowest foundation 280 ft. (*ENR*, Dec. 27, 1934, p. 823). The unusual feature of the dam is a vertical joint near the maximum cross-section. This joint (Fig. 1), which has several offsets in the vertical plane to give sliding contact faces or planes parallel to the direction of movement believed to have occurred in an old fault which crosses the dam site, was put in so that if any future movement occurred on the old fault it would not damage the structure seriously. One objective of the test was to determine whether the two parts of the dam act together in resisting vibrational forces.

The instrument used for measuring and recording vibrations was a vibration-recording meter with magnification factor 1400. When it was set up on the dam the first endeavor was to check the computed period of vibration of the structure. Assuming a rigid foundation, the computed value is about 0.14 sec. The observed period under vibrations set up by wind alone, when the water level was 110 ft. below the roadway across the crest of the dam, was observed to be between 0.16 and 0.17 sec. Records obtained at the time of a heavy blast in a quarry some 3 mi. away indicated periods from 0.14 to 0.18 sec., with the dominant period between 0.16 and 0.17 sec. The shaking machine produced two pronounced resonance peaks, one at 0.17 and the other at 0.20 sec.; the water at this time was 87 ft. below the crest.

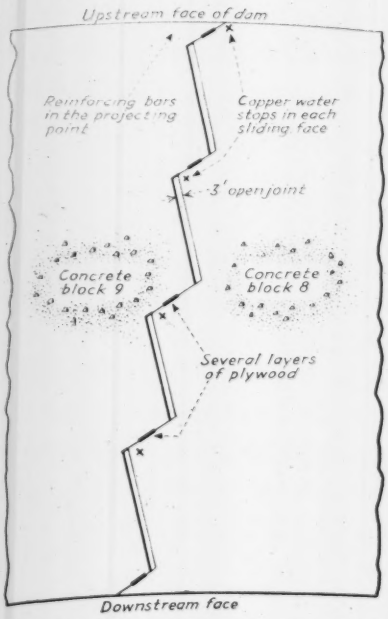

Upstream face of dam
Reinforcing bars in the projecting point
Copper water stops in each sliding face
3' open joint
Concrete block 9
Concrete block 8
Several layers of plywood
Downstream face

Fig. 1. Sliding type of joint which divides Morris Dam into two units over an old fault.

No entirely adequate explanation has been found for the fact that there were two periods, but it was definitely concluded that the shorter of the two, that is, the 0.17-sec. period, is the natural period of the dam. Whether the difference between computed and observed values can be used as a factor in analyzing foundation conditions has not been determined.

The advantage in the shaking machine, as compared to observing the effects of outside forces, is that the vibrating force set up mechanically can be definitely controlled, thus making it possible to repeat extensive tests under the same conditions. However, the only machine available for these tests was entirely inadequate for a complete series of vibrations of the order required in a massive structure such as a gravity-section dam. The machine used was designed for making vibration tests in buildings whose periods range from 0.1 to 1.0 sec. To be most effective in a structure like Morris Dam a machine should have a large energy output while developing vibrations with periods as low as 0.03 or 0.04 sec. A machine built for speeds high enough to develop short periods (high frequencies) of this order would be very expensive.

But even with the small machine available it was possible to set up measurable vibrations in Morris Dam within a certain period range. The records here described are limited, of course, to vibrations within this range. Each period of vibration in the dam represents a definite speed of the shaking machine, and for each speed a definite and constant vibrating force was set up. By making a number of runs with the recording instrument set, successively, at various points along the crest of the dam, and by orienting the charts to the same speeds for each station where the recorder was set up, the results were taken to be the same as simultaneous observations at the several points of observation.

After measuring the amplitude of vibrations at various points in the structure, energy absorption curves could be drawn for this particular mass of concrete. In Fig. 2 such curves are shown for periods of 0.14, 0.17, and 0.20 sec. These curves are

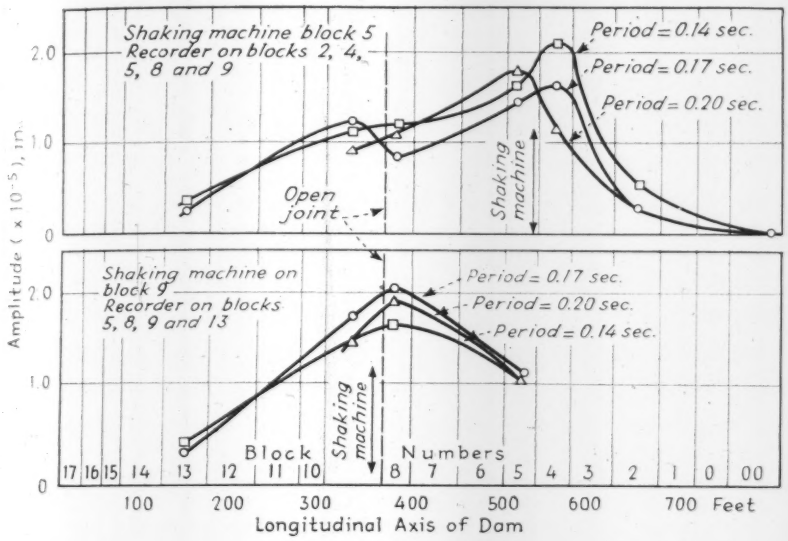

Shaking machine block 5
Recorder on blocks 2, 4, 5, 8 and 9
Period = 0.14 sec.
Period = 0.17 sec.
Period = 0.20 sec.
Open joint
Shaking machine
Shaking machine on block 9
Recorder on blocks 5, 8, 9 and 13
Period = 0.17 sec.
Period = 0.20 sec.
Period = 0.14 sec.
Amplitude (x 10⁻⁵), in.
Block Numbers
17 16 15 14 13 12 11 10 8 7 6 5 4 3 2 1 0 00
100 200 300 400 500 600 700 Feet
Longitudinal Axis of Dam

Fig. 2. Deflection curves showing amplitude of vibration at different locations for two settings of shaking machine.

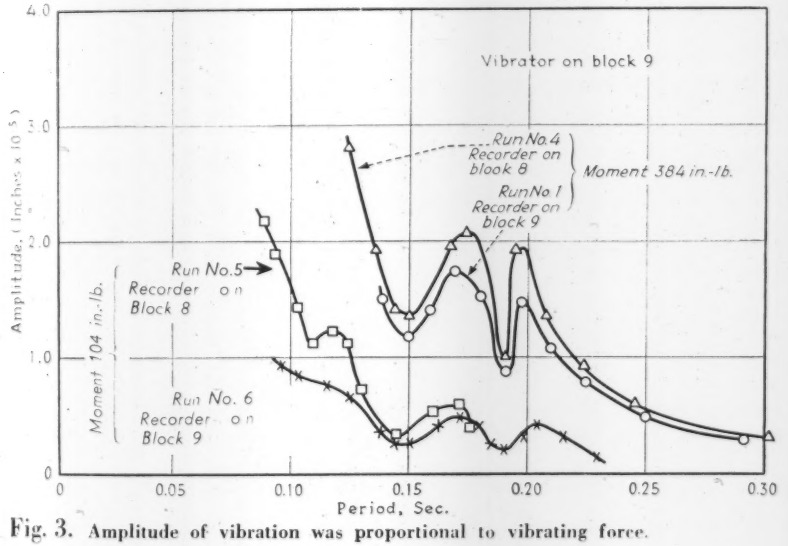

Vibrator on block 9
Run No. 4 Recorder on block 8
Run No. 1 Recorder on block 9
Moment 384 in.-lb.
Run No. 5 Recorder on Block 8
Run No. 6 Recorder on Block 9
Moment 104 in.-lb.
Amplitude, (Inches x 10⁻⁵)
Period, Sec.

Fig. 3. Amplitude of vibration was proportional to vibrating force.

very similar and show how the vibrations die out as the distance from the vibrating force increases.

With the shaking machine setting up vibrations, seventeen test runs were made, seven with the recording meter on the west side of the open joint and ten with the meter on the east side. These tests showed conclusively that the contact of the concrete blocks on opposite sides of the joint was sufficient to tranmit vibrations across it and into the concrete beyond. A curious fact was that in many cases the amplitudes of vibration were larger on the side of the joint away from the shaking machine than on the near side. This finding agrees with a similar result previously reported by seismic observers who have made tests in adjacent buildings with a light contact between them. In such cases old wooden forms or timbers between two concrete structures have been found not only to transmit vibrational effects across the gap but sometimes to cause amplitudes on the far side of the contact larger than in the structure where they originated.

Fig. 3 shows amplitudes of vibration as plotted for the various periods of vibration set up when the shaking machine, having been brought up to its maximum speed, is allowed to slow down. In this series of four runs, two moments of unbalance were used, as indicated. The moment of unbalance is determined by the amount and location of the eccentric mass. In these runs the eccentric masses were bolted to the disks at the same radius, thus making the moments of unbalance proportional to the weights. From the centrifugal force equation the vibrating force is directly proportional to the moment of unbalance.

A significant result observed in these tests is that in this structure, at least, amplitude of vibration is proportional to the vibrating force. If the amplitudes of the runs plotted in Fig. 2 are measured for the same speed, the ratio of amplitudes is found to be very nearly the same figure. That is, for the period of 0.17 sec. this ratio is 3.55 and 3.60 and for 0.20 sec. it is 3.55.

Summing up the results, the tests were interpreted as verifying the computed periods of vibration of the dam, and strengthened the confidence of the builders in its ability to resist earthquake shocks.

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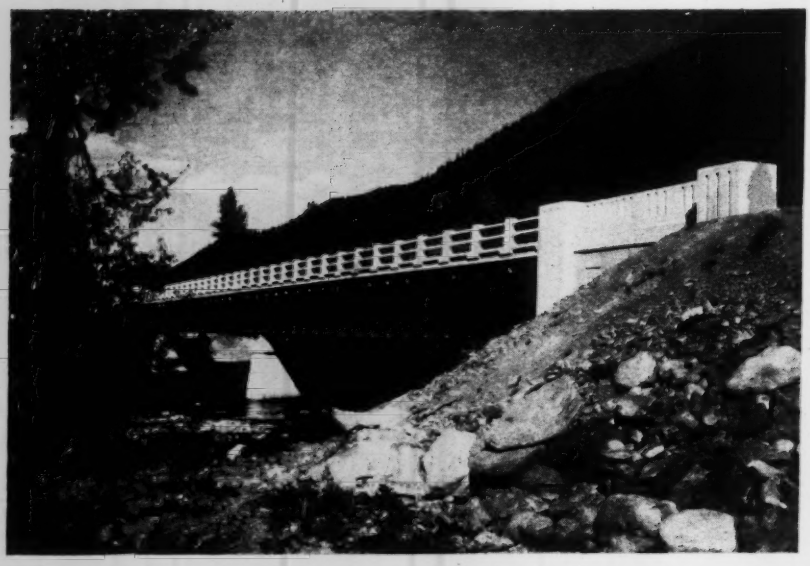
Single High Trestle for Coulee Dam Concrete

CONCRETE for the high dam at Grand Coulee will be placed from a single high trestle, now being built by the Bethlehem Steel Co. for Consolidated Builders, Inc., contractor on the dam. The structure replaces the two lower trestles built by the MWAK Co. for the base of the dam. As described by the *Columbian*, publication of the contractor, the new trestle will be 3,600 ft. long and 43 ft. wide to carry four standard-gage railroad tracks. The deck will be supported by 34 towers. The structure will require more than 9,000 tons of steel, ranging from 14-in. H columns to 100-in. plate girders. (See construction picture on p. 168).

Deck level is El. 1180; present base of the dam varies from El 935 to El. 1005. As the top of spillway section will be El. 1260, and top of powerhouse sections El. 1311, some of the top concrete will be out of reach of the wide-gage concrete placing cranes operating on the trestle. For the base of the dam concrete plants were set up on each side of the river, one being fed by a cement pipe and belt conveyors carried on a suspension bridge.



CONTINUOUS BRIDGE OVER BLACKFOOT RIVER IN MONTANA

Continuous Bridges Approved

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Montana highway engineers find advantages of appearance and economy in continuous girder bridges

ROAD BRIDGE DESIGNING in Montana has turned definitely to continuous spans, and the experience has been highly satisfactory. No troubles of the kind predicted by the critics of continuous bridges have developed; no foundation failures have occurred and none is anticipated. Instead, the state highway engineers feel that they can point to a number of advantages gained. By being able to use longer spans, a greater number of deck bridges is possible; longer spans also reduce substructure costs. Again, deck structures are given a more pleasing appearance and there is a saving in steel by the possible use of curved bottom chords. And, finally, deflections are reduced so that rolled beams can be used for much longer spans.

Some of the bridges built in Montana and some of the continuous bridge thinking that has developed out of their design and construction has an experience value that the writer finds helpful. One conviction arrived at is that deck bridges are preferable to through bridges for practical and esthetic reasons. The seemingly confined space of a through bridge tends to have a psychological effect on a driver which interferes with his driving, and his vision is restricted by the multiplicity of the members of the ordinary through bridge. From an artistic standpoint, the view from the inside of a through bridge is not especially inspiring to anyone but a structural engineer.

In deck bridge design the shallower depth of continuous spans gives them an advantage over long simple spans, where headroom is limited. Long deck spans have a better appearance when the bottom chords or the bottom flanges are made curved. Such shapes are ideally suited to continuous bridges as the greatest depth occurs over the piers where the moments are greatest. The use of deck bridges also permits the use of much shorter piers and abutments giving substantial savings in substructure costs. Pier tops are also narrower, as one shoe is used instead of two, resulting in further savings.

The writer believes that many continuous bridge layouts have been spoiled by the use of too many and too short spans. Bridges of this type are monotonous in appearance, and one also has the feeling that, by the use of longer spans, the substructure savings would have made the longer and fewer span layout the more economical and certainly a better appearing job. Any layout with an odd number of spans has a better appearance than one with an equal number of spans, and thus three-span continuous bridges will always be preferable to four-span continuous layouts if costs are the same.

The majority of the late designs of continuous bridges by the Montana state highway department have a three-span symmetrical layout. It is found, as the result of many designs employing different span ratios, that the ideal ratio for a three-span continuous bridge is about 1:1¼:1. It gives a better appearance and usually fits the crossing better to have the center span longer than the end spans. This ratio also balances the moments and deflections in the three spans. The positive moments in the end spans are about equal to the positive moments in the center span, and the relative deflections for all the spans are also about the same. Employing the above ratio, designs using 36-in. rolled beams of light section have been made with the end spans 80 ft. long and the center span 100 ft. long for an H-15 loading without exceeding an allowable deflection of 1/800 of the span length. Of course conditions often require that other span ratios be used but, despite departures from the ideal, continuous spans usually offer distinct advantages.

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Bicycle Paths Planned On New York Parkways

PARK COMMISSIONER Moses of New York City has announced plans for a comprehensive network of bicycle routes in the principal New York City parks and along the new parkways. Moses made his statement in connection with the opening of a 2½-mile bicycle road on the site of the old Vanderbilt speedway, long a private express road in Long Island and recently turned over to the Long Island counties which it traverses.